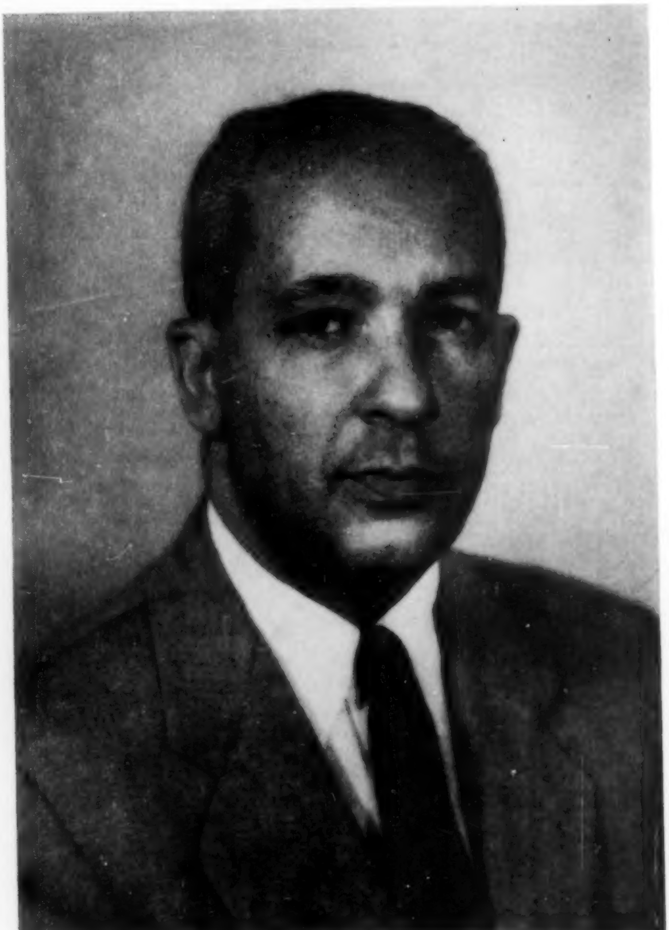
SCIENCE EDUCATION



Waldo W. E. Blanchet

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SCIENCE EDUCATION

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PRINCIPLES OF SCIENCE: A LOOK AHEAD *

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The Thirty-First Yearbook Committee of the National Society for the Study of Education stated that one of the objectives of science teaching is "the functional understanding of the major generalizations of science and the development of associated scientific attitudes." Prior to the publication of *A Program for Teaching Science* some studies of principles of science had been made either by or under the direction of Downing at the University of Chicago, Curtis at the University of Michigan, and Craig and Powers at Columbia University. The findings of these studies were presented either as lists of principles of science or as lists of topics in which a topic as stated suggested the principle of science associated with it. The Thayer Commission of the Progressive Education Association, also, recommended "principles" as the focal points around which to develop "understandings." A third committee that was national in scope was the Forty-Sixth Yearbook Committee of the National Society for the Study of Education; it, also considered one of the objectives of science teaching to be "the functional understanding of principles of science."

Although these national committees recommended that materials of instruction be organized around principles of science, it is to be remembered that older research studies, the findings of which were given as lists of topics, by implication, at least, dealt, in some manner, with principles. For example, if "levers" appeared as a topic among a list of topics, the principle of the lever, although it is not stated, may be considered as implied by the topic. "Boyle's Law," or any other law by name, whenever it appeared as a topic, clearly denoted the statement which embodies the law. No doubt, instruction in science has always given some attention to principles; however, the impetus to an interest in principles of science was given by the Thirty-First Year book and by the research directed by Downing, Craig, Powers, and Curtis, all of whom were members of the committee which prepared the report.

To "Look Ahead" at an understanding of principles of science as an objective of science teaching, it is well to find out where we are in research on principles of science. While no two persons will classify research on principles of science in the same way, it will be profitable for this discussion to use the following classifications: (1) refinement of statements of principles, (2) formulation and compilation of lists of principles in different subject-matter fields, (3) evaluation of principles an understanding of which is important as content for courses in science at the elementary, secondary, and junior college levels, (4) experiments and activities which contribute to developing an understanding of principles, and (5) the as-

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sociation of principles and concepts in one subject-matter field with principles and concepts in another. In discussing these various categories, the research studies that will be cited will be for illustrative purposes only and are not meant to be inclusive of all the research on principles of science. When Miles completed his dissertation in 1947, he stated that there were 44 research studies on principles as objectives of instruction in science. He did not include his own study which made a total of 45. Since 1947, there have been other major studies of principles such as the studies by Mallinson, Glidden, McKibben, Bergman, Irish, Caldwell, Smith, Leonelli and Washton.

REFINEMENT OF STATEMENTS OF PRINCIPLES OF SCIENCE

In research studies in which lists of principles of science in a particular subject-matter field were compiled, investigators developed criteria for judging whether a statement embodies the idea of a principle.

Heineman developed a broad definition of a principle as follows: "A statement of relationships frequently casual in nature between two facts." It is not to be confused with a "generalized fact" such as, "insects have six legs." "The principle or generalization is built on the basis of general facts, but once molded, it serves to make meaningful other facts and conditions."

Sites states that "A principle is a statement of relationship which is significant in its applications."

In his study of principles of science for the elementary grades, Robertson gives five criteria of a principle:

1. To be a principle, a statement must be a comprehensive generalization.
2. It must be true without exception within the limitations specifically stated.
3. It must be a clear statement of a process or an interaction.
4. It must be capable of illustrations so as gain conviction.
5. It must not be a part of a larger principle.
6. It must not be a definition.
7. It must not deal with a specific substance or variety, or with a limited group of substances or species.

As a basis for judging whether statements about chemical phenomena were statements of generalizations of chemistry, Pruitt set up seven criteria:

1. A generalization shall be as simple, comprehensive, and definitely stated as possible.
2. A generalization must be a statement of some fundamental process, or constant mode of behavior or property relating to natural phenomena.
3. A generalization must be true without exceptions within the limitations made in the statement.
4. A generalization must be a statement capable of demonstration.
5. A generalization must not be subordinate to a larger generalization.
6. A generalization must not deal with specific or limited groups of substances.
7. A generalization must not be a definition.

In compiling a list of generalizations of geology, Arnold used the first four criteria of Pruitt's list of criteria as his bases for judging whether a statement of geology was a statement of a generalization of geology.

Wise set up four criteria of a principle of science in compiling a list of principles of physical science:

1. To be a principle a statement must be a comprehensive generalization describing some fundamental process, constant mode of behavior, or property relating to natural phenomena.
2. It must be true without exception within limitations specifically stated.
3. It must be capable of illustration.
4. It must not be a definition.

In his study of principles of biological science for general education, Martin lists two criteria of a principle with two subheadings under each:

1. It must be a comprehensive generalization which resumes the widest possible range of facts within the domain of facts with which it is directly concerned. The facts resumed in the generalization must denote:

A. Objects and/or events and the relations between them.

B. Properties.

2. It must be scientifically true. To satisfy this criterion:

A. It must be verifiable, i.e., it must be stated so that it suggests either directly or indirectly,

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a definite operation of observation or experiment whereby its truth value can be tested or verified.

B. It must be consistent with the body of accepted scientific knowledge, and except for a few limiting or singular exceptions, with all the data (facts) relevant to it.

As a basis for identifying principles of entomology, Bergman defines a principle as follows:

The principle is taken to be a verifiable, scientifically true comprehensive generalization or fundamental statement for which the widest possible range is given and which describes some fundamental structure or process, constant mode of behavior, or property relating to natural phenomena.

A main principle is one which encompasses many major principles such as life exists in the form of living things.

A major principle is one which is fundamental but which is not as inclusive as a main principle.

A minor principle, or sub-principle is a minor generalization which is subordinate to a major or larger generalization or more fundamental statement.

Glidden used a set of three criteria for principles of soil and water conservation:

1. To be a principle a statement must be comprehensive generalization expressing a relationship between facts in the area of soil and water conservation which can be verified by demonstration or by observation of natural events.
2. It must be true without exception within limitations specifically stated.
3. It must not be a definition.

For selecting principles of earth science, Caldwell used Martin's set of criteria of a principle.

The criteria developed by these investigators are similar; yet, there are differences among them. No doubt each investigator who formulated a set of criteria felt that his set was more discriminating in selecting statements of principles than the preceding ones. The criteria may be subject to criticism and, therefore, the statements of principles based on them may, also, be subject to criticism. However, science education owes a great deal to these investigators who, virtually plowed through the literature in their respective fields of study and unearthed many hundreds and thousands of statements which gave promise of being statements of principles. If a statement that was selected did not meet in full, all of the criteria of a principle, it was re-worded to do so; if it could not be re-worded to satisfy the criteria, then it was discarded. The various lists of statements that are available contain statements of principles or generalizations which are based on criteria. These criteria, then, provide evidence that investigators have been concerned with the accuracy with which principles and generalizations are stated. Other investigators may wish to refine criteria of principles to make them more discriminating in locating principles and thereby differentiate between principles and generalizations.

FORMULATION OF LISTS OF PRINCIPLES IN DIFFERENT SUBJECT-MATTER FIELDS

Each broad subject-matter field has been studied with a view to identifying principles or generalizations in that field.

Sites, Pruitt, and others have compiled lists of principles of chemistry.

Downing with his students compiled lists of principles of physics.

From an analysis of 22 books containing materials of geology, Arnold compiled a list of 2,128 generalizations of geology.

Wise consolidated principles of physical science from a number of lists of principles and along with some principles which he identified formulated a list of 272 principles of physical science.

Martin, using a number of different sources such as research studies plus locating additional principles, compiled a "master" list of 300 principles of biological science and a "minor" list of 236 generalizations of the biological sciences. It is to be noted that one list consists of principles and the other generalizations.

Bergman's research on principles provides a list of 52 principles of entomology.

As a result of his research, Glidden abstracted from the literature of soil and water conservation, 66 principles of soil and water conservation.

Earth science was studied by Caldwell for the purpose of identifying principles of earth science; he compiled a list of 296 principles of earth science.

In those studies whose findings are in the form of lists of principles of science in different subject-matter areas, in general, the following procedure was used for locating statements of principles:

1. Adopted a set of criteria of a principle.
2. Set up criteria for the selection of source materials from which to select statements of principles.
3. Selected the source of materials.
4. Read the source materials and selected statements which seemed to be statements of principles.
5. Applied the criteria of a principle to these statements, retaining those statements which seemed to meet the criteria in full and those which when re-worded also satisfied the criteria and discarded those which did not meet the criteria or could not be re-worded to do so.
6. Submitted the list of statements to groups of specialists, each of whom checked the statements in his field of specialization against the criteria of a principle.
7. Made revisions in the wording of a statement as advised by a specialist and discarded statements which were not approved by the specialists.
8. Compiled a list of principles or generalizations in geology, physical science, biological science, earth science, soil and water conservation, *et cetera*.

Refinements in these main steps may be made at different points in the procedure. For example, in step three, the source materials may be submitted to specialists to judge whether the sources that have been selected satisfy the criteria for the selection of materials to be read. In a number of the studies use was made of lists of principles that had already been compiled and additions to these lists were made by the investigator.

EVALUATION OF PRINCIPLES

Within the last ten years, attention has been given to the evaluation of principles of science for the purpose of finding out what content should be included in elementary science and in certain courses in science on the secondary and junior college levels. Blanchet had principles of physical science evaluated for general education physical science at the college level. Washton developed a list of principles for college-level general education biological science and Blanchet had college teachers of biological science evaluate principles of biology for general education biology at the junior college level. In Miles' study, principles of physical science were evaluated for an integrated physical science course for the secondary level. McKibben had principles of biological science evaluated for a general biology course in high schools. In his research in general science, Smith had principles of science evaluated for a high school course in general science. Leonelli had principles of science evaluated for different grade levels in the elementary school.

All of these studies with the exception of Washton's study dealing with content for general education biology at the college level used the lists of principles that had been compiled by Wise and/or Martin. Washton used the first 100 principles of Martin's list and by integrating several of them into one principle compressed the 100 statements into a list of 42 principles of biological science.

It is to be remembered that Wise compiled a list of principles of physical science and had each principle evaluated for purposes of general education for grades I-XIV. Martin developed a "master" list of 300 principles of biological science for general education grades I-XIV. The principles of science in a large number of major studies of principles of science which had been completed prior to Wise's study and Martin's study were consolidated in one form or other in these two lists of principles.

Principles of science lend themselves very nicely to studies which involve the evaluation of principles for whatever purpose an investigator wants them evaluated. Martin's list of principles of biological science and Wise's list of principles of physical science contain principles of science that are important for general education

for grades I-XIV. It may be assumed, therefore, that content in the form of principles of science may be obtained from these two lists for general education courses in science at the elementary, secondary, and college levels.

The research techniques for evaluating principles of science follows a general pattern which uses the judgment of a jury. Kesslar has been of great help to investigators in this area of research, for his research on the judgment of juries reveals that a small number of well-qualified evaluators is just as effective as a large number. In having principles of science evaluated, investigators usually:

1. Set up aims or purposes of a course for which principles of science are to be evaluated.
2. Submit this set of aims along with a list of principles to specialists who are asked to evaluate, on some numerical basis, each principle on a basis of the contribution that an understanding of that principle may make to the aims of the course.
3. Compute statistically the composite evaluations of each principle based on the evaluations made by the evaluators; the composite evaluation of a principle is assumed to represent the value of that principle.
4. Arrange the principles in descending order of their composite evaluations.

EXPERIMENTS AND ACTIVITIES WHICH CONTRIBUTE TO AN UNDERSTANDING OF PRINCIPLES OF SCIENCE

Another area of research with principles of science that has received some attention by investigators is the area of laboratory activities. After principles of physical science had been evaluated for use in an integrated physical science course on the high school level, Miles, through appropriate technique compiled a list of experiments, respectively, for each principle of physical science which was important for inclusion in the integrated physical science course.

Smith compiled a list of experiments which are important for developing an understanding of the principles of science which had been evaluated as desirable for inclusion in a course of general science at the junior high school level.

In an analysis of principles and activities of importance for general biology courses in high school, McKibben brought together a list of activities for each principle of biological science an understanding of which was considered important for a general biology course.

In all three of the studies, similar techniques were used:

1. The value of certain principles of science for inclusion in each course was determined by a technique similar to the one that has already been described for evaluating principles of science.
2. Criteria, either stated or implied, were formulated for selecting textbooks, workbooks, laboratory manual, *et cetera*, as sources of experiments and activities.
3. Experiments or activities were selected from these sources.
4. A question was formulated for each experiment or activity which clearly suggested what the experiment or activity was and the answer to which could be obtained by performing the experiment or engaging in the activity.
5. A principle of science was selected and written on a sheet of paper and under the statement of that principle were placed all of the experiments or activities which, in the opinion of the investigator, if performed or engaged in, would contribute to an understanding of the principle.
6. The complete list of principles of science with the assigned experiments or activities was submitted to a few evaluators who were asked to state whether each experiment contributed to an understanding of the principle to which it was assigned, to indicate on some numerical scale the extent to which the experiment is desirable for a particular course, and to state whether each experiment would be performed more appropriately as an individual laboratory experiment or as a demonstration.
7. Statistical calculations were made of the numerical evaluations given to an experiment by the evaluators; the composite evaluation of an experiment or activity represents the value of that experience or activity.
8. The experiments that had been assigned to a principle were then arranged in descending order of value and some appropriate designation was made to show whether the experiment should be performed as an individual laboratory experiment or as a demonstration.

ASSOCIATION OF PRINCIPLES AND CONCEPTS IN DIFFERENT SUBJECT-MATTER FIELDS

There have been a few studies in which investigators related principles or concepts

in one field of science to principles of biology and/or physical science.

Bergman assigned principles of entomology to 27 major and 18 minor principles of biology; 30 major principles of entomology are subordinate to 23 major principles of biology; 15 major principles of entomology are subordinate to 15 minor principles of biology; and 7 minor principles of entomology are subordinate to 7 minor principles of biology.

Mallinson identified 74 categories of consumer science. Seventy-three of these categories were assigned to principles of science and/or attitudes. Thirteen were assigned to 10 principles of physical science to the understanding of which they were judged to contribute and 45 were similarly assigned to 18 principles of biological science.

Irish assigned aspects of soil conservation to 3 principles of physical science and to 6 principles of biological science.

Two or three years ago, Washton, started a study the purpose of which was to find out which principles of physical science had implication for developing an understanding of certain principles of biology.

Would it be stretching science too far afield to do some research on the implications that principles of science may have for developing an undersanding of concepts in a field that is considered to be unrelated to the field of science? Would it be fruitful of results that are worthwhile for course organizations, for example, to find out what implications principles of biology may have for developing an understanding of concepts of sociology? Is it desirable to integrate the content of science with the content of another subject-matter field?

CONCLUSIONS

From the research on principles of science that has been referred to, the following conclusions may be drawn:

1. For the past thirty years research investigators in science education have given attention to principles of science; however, a large number of major studies of principles of science were undertaken and completed after the publication of the Thirty-First Yearbook of the National Society for the Study of Education.
2. There is an ample supply of principles and generalizations of science for use of textbook writers, teachers, and curriculum makers; lists of principles and generalization of science are available in physical science (including primarily physics and chemistry), biological science, geology, entomology, soil and water conservation, earth science, and by implication consumer science.
3. From the use of criteria in judging whether a statement embodies the idea of a principle of science, there is evidence that investigators have been concerned with whether a statement is a principle and whether the statement is an accurate statement of that principle.
4. There are now available lists of principles of science which have been evaluated for various courses in science on the elementary, secondary, and junior college levels and for purposes of general education in grades I–XIV.
5. There are available many experiments and activities which may be used for developing understanding of principles of science to which these experiments and activities have been assigned.
6. For extending the meaning of principles, there are available principles of entomology, concepts of soil conservation, and concepts of consumer science that are related to principles of physical science and/or principles of biological science.
7. The distinction between what is a principle of science and what is a generalization of science is not clear.

A LOOK AHEAD

As has been stated before, there is an ample supply of statements of principles and generalizations of science. There are over 3,000 such statements. Although principles of science lend themselves very nicely to research, at the moment, there does not seem to be need for increasing the number of principles and generalizations of science. The lists of statements that we now have need to be refined. There are several ways in which this may be done. One way involves general agreement on the criteria of a principle of science. A second method would be to reduce the number of statements by eliminating duplicate statements and by consolidating two or more statements into one statement. A third way of refining lists of principles is to

formulate an outline of principles in which principles that are narrow in scope are related to larger principles which are broad in scope. A fourth method involves relating principles in one subject area to principles in another subject area.

A committee of the National Association for Research in Science Teaching has defined what it considers to be research in science education. In their review of research, all level committees of this association have applied that definition of research in science education to studies which were selected for review. To bring order out of the large number of statements which are said to be statements of principles of science, there is need of a set of criteria that is generally accepted as the criteria of a principle of science. Of the investigators, in recent years, who have compiled lists of principles in certain subject-matter areas, Caldwell is the only one who used a set of criteria that had been used before. He used Martin's criteria of a principle. Each of the other investigators used a different set of criteria. No doubt, each investigator was concerned with the accuracy with which a principle is stated; thus, different sets of criteria were formulated. However, two questions immediately arise. What is a principle of science? Is the nature of a principle of biology different from a principle of physics, chemistry, entomology, earth science, or soil and water conservation?

Washton's work in the area of general education biology at the college level suggests a way of refining lists of principles by decreasing the number of principles. He analyzed the first 100 principles of Martin's "master" list of 300 principles of biological science and through appropriate technique compressed the first 100 principles into 42 principles. In applying this technique, it is well to begin with those principles among which the relationships are obvious. For example, there is little question that many of the individual principles dealing with atomic structure could be consolidated into a smaller number of principles. Perhaps an analysis of statements of principles will reveal that statements of so-called principles have additive properties and two or more statements may be integrated into one statement which states a principle that is more inclusively worded than any of the other statements. The danger in using this technique is that the statement which results from consolidating two or more statements is so broad in scope that it does not suggest the depth of experience and the kinds of relaships required for developing an understanding of it. Lists of principles, therefore, need to be examined very critically to eliminate duplicate statements and to relate those principles which are obviously related.

In compiling a list of principles for elementary science, Robertson found that certain principles of science were subsidiary to another principle which was broad in scope; therefore, in formulating his list of principles, he listed one or more subsidiary principles, as the case may be, under a more inclusive one. Lists of principles could be examined to identify those principles which are broad in scope, then subsidiary principles could be related to them. The point of focus becomes the larger, more inclusive principle, the understanding of which becomes one of the objectives of experience in science.

Many of us, at one time or other, have used a jury of evaluators to evaluate principles for various courses. Even though Keeslar has shown that few or many well-qualified evaluators may be used, it is questionable how discriminating these evaluators have been in evaluating principles, for there continue to be large numbers of principles of science which evaluators consider important for any particular course. On the other hand the fact that evaluators continue to rate a large number of principles as important for any course may suggest duplications of principles in any list of principles submitted to them for

evaluation. The technique of using a jury of evaluators, will, no doubt, continue to be used; however, such a technique might well be supplemented by a technique suggested in the work of Mallinson, Bergman, and Irish.

In supplementing the evaluation of principles by a jury with techniques suggested by the studies of Mallinson, Bergman, and Irish, a principle is important for a certain course, not only because a specialist says it is, but in addition, it is important because it is related to something else that is important. The more varied are the ramifications of a principle, the more opportunity one has for seeing it operate in a number of different situations. It is hoped, of course, that those situations in which it is seen to operate are meaningful ones. There is, thus, suggested a second point in looking ahead at principles of science as objectives of science teaching.

Up to now, in compiling lists of principles of science, investigators have been concerned with the scientific accuracy of statements of principles. And it is these scientifically accurate statements which evaluators have rated. Surely science for general education, at any level, is more than an understanding of the science involved in a principle of science. When Mallinson relates concepts of consumer science, Irish concepts of soil conservation, and Bergman principles of entomology particularly those principles dealing with disease and control of insects to principles of science, there is implicit in this method, the extension of the meaning of principles of science beyond mere science, however important science as science may be, into the dynamics of living. At the meeting of the American Association for the Advancement of Science last December, the persons who summarized research in science education at the elementary, secondary, and college levels and those persons who discussed the implications of the research cited, emphasized the need for relating science to the living experiences of boys and girls and youth.

A functional understanding of principles of science is not incompatible with relating science to the living experiences of boys and girls and youth. While a principle of science, an understanding of which you hope a student will acquire, must be scientifically true, the value of it for the student lies in its significance for the problems which he faces.

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WALDO WILLIE EMERSON BLANCHET

To Dean Waldo Willie Emerson Blanchet goes the honor of being the Twenty-Fourth President of the National Association for Research in Science Teaching and the recipient of the Fourth Science Education Recognition Award. After many years as a most active and valued member of the National Association for Research in Science Teaching, Dean Blanchet deservedly merits these two distinctions. He follows a long line of distinguished science education leaders who have served as President of NARST.

Dean Blanchet was born in New Orleans, Louisiana, August 6, 1910. He married Miss Josephine Lavizzo, October 13, 1943. They have two children, a daughter Geri Therese age eight, and a son Waldo W. E., age six.

Educational training includes A.B. degree Talladega College 1931; M.S. (1936) and Ph.D. (1946) degrees from the Uni-

versity of Michigan. Dean Blanchet also attended Atlanta University 1931–32 and two summers at the University of Chicago (1936 and 1937). The title of his Ph.D. dissertation was *A Basis for the Selection of Course Content for Survey Courses in the Natural Sciences.* During 1929–30 he was awarded one of ten college Alpha Phi Alpha Fraternity Scholarships; a Talladega College Scholarship for 1931–32; an Atlanta University Fellowship in Chemistry for 1931–32; and General Education Board Fellowships in 1935–36 and 1938–39. He was elected to University of Michigan Honor Societies of Phi Delta Kappa and Phi Kappa Phi.

Teaching experience includes Head of Science Department of the Fort Valley Normal and Industrial School 1932–35 and 1936–38, and Professor of Physical Science and Administrative Dean of Fort Valley State College, Fort Valley, Georgia since 1939. Thus Dean Blanchet is now completing twenty-five years of teaching and administrative work at the Fort Valley State College.

Memberships in organizations include National Association for Research in Science Teaching, National Institute of Science, American Association for the Advancement of Science, National Association of Collegiate Deans and Registrars, Beta Kappa Chi Scientific Society, National Education Association, National Science Teachers Association, Georgia Teachers Association, Georgia Education Association, Phi Delta Kappa, and Phi Kappa Phi. Dean Blanchet is listed in *American Men of Science, Leaders in Education, Who's Who in American Education, Who's Who in Colored America,* and *Who's Who in the South.*

Dean Blanchet is a Fellow in the AAAS; has served as Executive Committee member and Vice-President of NARST; on the NARST College Level Committee and the Committee on Educational Trends; Georgia State Committee on the Improvement of Science Teaching in Georgia and also a member of the Committee of the University System of Georgia on Improvement of Science Teaching; numerous other professional committees in Georgia; Evaluating Committees for Georgia High Schools, and so on. He was Vice-President of the National Institute of Science in charge of science education and was Chairman of the Committee on Cooperation in Teacher Education.

Publications include a number of articles in *Science Education;* also articles in *Morehouse Journal of Science, The Southern Churchman, Quarterly Review of Higher Education Among Negroes,* and *Proceedings of the Association of Colleges and Secondary Schools for Negroes.* He also contributed a chapter on Measurement of Opinions and Attitudes in *A Review of Educational and Psychological Tests and Their Uses.*

Hobbies and present interests include playing bridge, reading mystery stories, collecting textbooks on physical science general education courses, the total general education program, and in improvement of science teaching in colleges and secondary schools.

An active and distinguished member of numerous science education organizations, Dean Blanchet highly merits his honors as Twenty-Fourth President of NARST and recipient of the Fourth Science Education Recognition Award.

CLARENCE M. PRUITT

ALUMNI OPINIONS ON COLLEGE GENERAL-EDUCATION SCIENCE

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This study investigated the opinions of some members of the alumni of Morgan State College on certain topics which might be included in two general-education courses in science. The findings directed attention to the preferences expressed by the alumni, as contrasted with the opinions of students and the general faculty, concerning what topics of study should be incorporated into courses of this kind.[1] The findings also provided data of value in the construction of syllabuses for these two courses.

In addition to determining the needs expressed by the alumni, and comparing them with student and faculty evaluation of the topics, the study attempted to answer the following questions: What relative importance do these three groups assign to the 52 selected topics which were included in the questionnaire as a part of general-education science? What are the implications of the findings for the development of general-education science at Morgan State College?

A questionnaire was employed containing 52 selected topics which might be included as a part of general education courses in science. A preliminary form of this questionnaire prepared by a faculty committee on general-education science was evaluated by some members of the faculty outside of the division of natural sciences and by the Dean of the College. On the basis of the responses received from these individuals and groups, the questionnaire was revised and circulated among 200 members of the alumni in the spring of 1952 for completion.

Returns were received from 45 members of the alumni which represented 22.5 per cent of the questionnaires distributed. Respondents were residing in Maryland, Delaware, New Jersey, District of Columbia, New York, Pennsylvania, Virginia and Texas.

Respondents were asked to indicate their opinions on the relative importance of the inclusion of the 52 items in general-education science by checking one of three columns headed: should be included, should not be included, and uncertain as to whether or not it should be included. The replies received from the alumni were tabulated separately for each of the three ratings, and the numbers were then translated into percentages.

The column indicating that the topic should be included provided a range extending from the highest to the lowest percentage of individuals who checked the column. The range extended from 97.7 to 71.7 per cent.

In the findings, the convictions of the alumni on the 52 topics were compared with those of students and the general college faculty.

The percentages were then ranked. For example, "the characteristics of living things" and "current events in science" were each marked "should be included" by 97.7 per cent, the largest percentage of the alumni responding. Four items, "contributions of science and scientist to the life of our times," "conservation of natural resources (including human)," "the importance of environmental factors to life," and "the role of chemistry in human welfare" were marked "should be included" by 95.5 per cent, the second highest percentage. In order to rank the ten highest percentages

[1] For an earlier discussion of the opinions of students and faculty on college general-education science, see Thomas P. Fraser and John W. King, "Opinions on General Education Science," *The Journal of Higher Education*, XXV (May, 1954), pp. 274–276.

See also Thomas P. Fraser, "A Study of the Opinion of Students on College General Education Science," *Science Education*, 39 (April, 1955), pp. 213–219.

of alumni opinion, it was necessary to include 49 topics, ranging in percentages of approval from 97.7 to 77.7. The ten highest percentages of faculty opinion included 38 topics, ranging in percentages of approval from 97.6 to 74.4. The ten highest percentages of student opinion included 12 topics, ranging in percentages of approval from 99.1 to 89.3.

The alumni percentages and ranks for the 52 topics are given in Table 1; in the last four columns of the table appear the student and faculty percentages and ranks for these items.[2]

Members of the alumni assigned the ten highest ranks to all topics included in the questionnaire except three, "the discovery and harnessing of different forms of energy," "conditions determining our weather and climate," and "the transmission of energy through 'ether' and through water by means of vibrations." Comparisons between the alumni and students showed that they were fairly closely related in the rank-order of preferences. The comparisons between the alumni and faculty showed a low but positive relationship in the rank-order of preferences. In other words, there is a closer relationship between student alumni opinions than between the opinions of the faculty and alumni. When students were compared with the faculty a relationship was present but was not too high.

Respondents were asked to suggest ad-

[2] Fraser and King, *loc. cit.*, pp. 274–276.

TABLE I

ALUMNI, STUDENT AND FACULTY RESPONSES TO FIFTY-TWO SELECTED COLLEGE GENERAL EDUCATION SCIENCE TOPICS

Topics	Alumni Responses		Student Responses		Faculty Responses	
	Per Cent	Rank	Per Cent	Rank	Per Cent	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4. The characteristics of living things	97.7	1.5	91.1	10	86	17
52. Current events in science	97.7	1.5	99.5	5	79.0	33.5
2. Contributions of science and scientists to the life of our times	95.5	4	94.6	6.5	90.6	7
3. Conservation of natural resources (including human)	95.5	4	87.6	14.5	88.3	11
32. The importance of environmental factors to life	95.5	4	84.0	18	97.6	1.5
51. The role of chemistry in human welfare	95.5	4	77.8	29	81.3	29
1. The role of the scientific method in solving problems	93.3	7	90.2	11	90.6	7
15. Human reproduction and sex education	93.3	7	97.3	3	86	17
27. Infectious diseases of man	93.3	7	96.4	4	79	33.5
6. The physical properties of living things	91.1	12	79.6	27	81.3	29
8. Food, digestion and assimilation in man	91.1	12	93.8	8	93	4
10. Circulation in man	91.1	12	94.6	6.5	86	17
28. The functional diseases of man	91.1	12	99.1	1.5	79.0	33.5
29. The operations of the carbon and nitrogen cycle in nature	91.1	12	66.3	38.5	83.4	22.5
36. Man's control of his material world through an ever-increasing understanding of its nature	91.1	12	83.1	19	88.3	11
50. Matter: its measurement, nature and changes	91.1	12	65.4	40.5	71.4	38
7. Support and movement in man	88.8	20.5	80.5	26	86	17
9. Respiration and excretion in man	88.8	20.5	92.9	9	83.4	22.5
11. How man hears and sees	88.8	20.5	89.3	12	88.3	11
12. How man tastes, smells and feels	88.8	20.5	88.4	13	88.3	11

TABLE I—(Continued)

ALUMNI, STUDENT AND FACULTY RESPONSES TO FIFTY-TWO SELECTED COLLEGE GENERAL EDUCATION SCIENCE TOPICS

13. The role of the nervous system in human adjustment	88.8	20.5	99.1	1.5	81.3	29
30. The interdependence of living organisms	88.8	20.5	76.1	31.5	97.6	1.5
37. The contributions of creative chemistry to man's physical progress	88.8	20.5	61.0	48	72.0	39.5
40. The nature and social implications of atomic energy	88.8	20.5	76.1	31.5	93	4
41. Some recent advances in science, e.g., plastics, electronics, atomics, etc.	88.8	20.5	81.4	24.5	90.6	7
44. The nature and composition of the atmosphere	88.8	20.5	78.7	28	81.3	29
17. The evidences for and the mechanisms of evolution	86.6	27	64.6	43.5	58.1	47.5
24. Primitive plants, algae, bacteria and fungi and their importance to man	86.6	27	66.3	38.5	55.8	51
26. The seed plants and their importance to man	86.6	27	74.3	33.5	67.4	43
5. The chemical composition of living things	84.4	32	67.2	37	70	33.5
14. The work of the endocrine glands	84.4	32	82.3	21.5	81.3	29
22. Vertebrate animals and their importance to man	84.4	32	76.9	30	69.7	41.5
42. The nature of the solar system	84.4	32	82.3	21.5	83.4	22.5
43. The nature of the earth and its movements	84.4	32	87.6	14.5	86.0	17
47. The important metals and their uses	84.4	32	74.3	33.5	81.3	29
49. The place of the earth in the universe	84.4	32	82.3	21.5	86.0	17
20. The worms and their importance to man	82.2	37	65.4	40.5	55.4	52
31. Drug addiction and alcoholism	82.2	37	86.7	16	81.3	29
39. The properties of solids, liquids and gases	82.2	37	70.7	36	69.7	41.5
18. The unicellular animals and their importance to man	80.0	41.5	64.6	43.5	58.1	47.5
21. The arthropods (insects, crabs, etc.) and their importance to man	80.0	41.5	64.6	43.5	58.1	47.5
25. Mosses and ferns and their importance to man	80.0	41.5	61.9	46	62.7	44
34. Applied knowledge of physical properties and physical changes in overcoming physical limitations	80.0	41.5	64.6	43.5	86	17
46. The changing surface of the earth and its role in supporting life	80.0	41.5	81.4	24.5	76.7	36.5
16. The improvement of living organisms through the application of the laws of heredity	77.7	47	85.8	17	72.0	39.5
19. The sac-like animals and their importance to man	77.7	47	53.0	51	58.1	47.5
23. The economic importance of other invertebrates	77.7	47	61.0	48	58.1	47.5
35. The importance of magnetism and electricity in human welfare	77.7	47	61.0	48	88.3	11
48. The nature of the earth's crust: its interior, energy resources and uses	77.7	47	71.6	35	76.7	36.5
33. The discovery and harnessing of different forms of energy	75.5	50.5	60.1	50	83.4	22.5
45. Conditions determining our weather and climate	75.5	50.5	82.3	21.5	93	4
38. The transmission of energy through "ether" and through matter by means of vibrations	71.1	5.2	38.9	52	58.1	47.5

ditional topics which might be included in general-education science, to give an explanation when the column captioned "uncertain as to whether or not (the topic) should be included" was checked and to make statements concerning the development of mathematical competence by students. The respondents suggested the following new topics: the significance of radio, television, telephone, and telegraph in communication; the moral responsibility of the scientist to his fellow-man;[3] the unifying principle of a Supreme Deity; first aid in emergencies; practical toxicology; the effects of environment upon heredity; the important chemical reactions which take place within the body, i.e., amino acid formation, acid-alkaline reactions, etc.; and the role of science in developing desirable social attitudes.

An alumnus asserted that, "these topics seem to me to be more closely allied with health education or physiology." It is recognized that the life processes as they are displayed in the human organism represent a unifying theme in general-education science courses.

Another alumnus, who had successfully completed two courses in general-education science, replied that, "the material suggested in the questionnaire should be carefully organized into two full courses, a year each under a physical and biological heading." A third alumnus replied that, "the science courses should be one year in length."

A few of the alumni expressed the need for including individual laboratory work as an integral part of the course.

Among reasons given by the alumni for uncertainty about the selection of topics for general-education science were: lack of course time in which to develop the topic adequately; the inclusion of the topic in other courses; understanding of the topic not necessary for everyday living; and lack of familiarity with the topic.

Thirty of 45 members of the alumni who commented on the development of mathematical competence indicated that the college should require students to demonstrate proficiency in mathematics before graduation. The consensus of opinion was that a course in functional mathematics should be required of all students who are judged to be deficient. Eight of 45 members of the alumni indicated that the course should be offered for credit. Four of the 45 members of the alumni indicated that the course should be offered on a non-credit basis. Three of the alumni expressed the opinion that, "mathematics is always useful," and "just as important as English in our modern world."

[3] A physician suggested this topic and commented that he felt "very strongly that science cannot either hold itself apart from morals or afford to send out 'educated' amoral technicians. A well-rounded man must be able to make informed judgments and decisions as to the results and effects of his work. It is not—in my opinion—sufficient to graduate people with a fund of factual knowledge and no feeling of responsibility for what they do with that knowledge."

EDUCATIONAL PSYCHOLOGY FOR THE BLIND

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ADLERAN psychology has a special application to the teaching of the blind because it deals with inferiority complexes, frustrations, possible anxiety, and fear neuroses. One problem confronted is the natural timidity or reticence peculiar to the sight handicapped. Introversion tends to be another factor that is characteristic of many sight handicapped people. In both introversion and inferiority complex tendencies, the teacher, using the best corrective methods in teaching, should try to

overcome them with the use of psychological tools; such as, projection, sublimation, rationalization, etc. Introversion can be largely overcome through active social contacts with both seeing and blind conferers, by worthy use of leisure, and by the desirable and pleasing vocations and avocations which seek to minimize their handicap. These characteristic complexes, tend to be methods of evasion to the blind, may be overcome in the high school by the efforts of the teacher in placing responsibility on the blind student; particularly in socialized recitations, debates, oral reports, and formal recitations. They should be treated as colleagues who need friendship and social equality instead of sympathy and frustrations. They can, through active social life with their seeing colleagues, utilize the mechanisms of evasion which tend to project themselves away from their circumscribed environment.

Whether or not the lack of sight with impairment of the nerve involved in vision affects the sensory or motor responses will vary with the individual cases. Some blind persons develop even in early adolescence amazing compensating factors utilizing their remaining senses as counter measures for satisfactory adjustment to their handicap. Without adequate guidance counseling, some blind persons tend to become maladjusted and emotionally unstable until teachers, colleagues, or psychiatrists can discover by diversified psychoanalytical methods defence projections or rationalizations which compensate for their sight loss.

CASE STUDIES

Student A was blind from an ill-directed x-ray treatment which, in addition, deformed the skin to such an extent that his appearance was repulsive. This student when he came to the writer, was an extreme introvert and naturally timid. The double affliction caused pity and unfortunate avoidance in the minds of his sighted classmates, which resulted in making him still more timid. The counter measures began when sympathetic seeing students were told that the skin condition was by no means infectious. Henceforth they were gradually able to overcome their antipathy and sense of repulsion. Student instructors took this student into an adjacent room and gave him separate instruction, using clay and cutout models. Tactual manipulation of all of the physical apparatus was encouraged during science laboratory periods. During recitations this student was called upon for numerous reports which he gave orally in front of the class. The seeing students admired his courage and were induced literally to bombard him with questions following an oral report. Seeing students began to take an interest in him and vied with each other for the honor of instructing him. This student has noticeably gained confidence. He has overcome some of his inferiority and timidity, and in addition, this pupil, who before was reticent in discussing his problems, now regards the writer as a friend and feels free, even eager, to discuss any of his adolescent perplexities with him. This same pupil has taken his part in the social life of a big school and has won many friends. He does not stand very high in mental ability tests and seems to have more difficulty than the other blind students in his achievement type examinations. He has, however, passed every academic subject so far, and his timidity has apparently been overcome. He takes interest in nature study, and in some of his units in physics, such as sound, mechanics, and electricity; and particularly likes to be called upon to assume responsibility in socialized recitations and debates. It will take a long time before he completely overcomes his inferiority complex outside of his school life, but in school it ceased completely. Later, away from school influence, he married a blind girl and ended up running a newspaper and candy counter in an office building until his repulsive appearance forced a change.

Some time ago the writer received from this boy a letter and he appeared to be quite

cheerful, having attained fair vocational success in an office as a typist. He thanked us for the encouragement that enabled him to overcome his handicap and meet most people without fear and self-consciousness.

Blind student B was totally blind from childhood. He had apparently been made an object of pity by his friends and relations, with his parents more or less indifferent to him. He was a typical hyperthyroid adolescent. This student had very little spatial sense, and he was unable to find his way around with the comparative ease of the other blind students. His acuity with his remaining sense perception was low. He was very dependent and of the inhibited emotional type, being unable to do things for himself without aid. He was retiring and tried to avoid, rather than come in contact with his confreres, either blind or seeing, and he tended to be egoeccentric. He had very poor muscle coordination, and was unable to use hands to carry out the simple tasks ordinarily required of the average person. He needed help in adjusting his clothing. He stumbled over stools and chairs, after he should have known their position in the classroom. He was a psycho-neurotic case, and when first brought into the classroom he visibly trembled whenever he was called upon for recitations. His articulation was poor, due probably to inherent nervous and anxiety tendencies. In an oral or socialized recitation, the rest of the students in the class were at a high emotional tension all of the time, due to the external nervous manifestations of the blind student while making oral reports and oral recitations. We found that by first asking him easy questions that required short answers only he was finally able to answer more clearly. From the single answer question method, we were gradually able to build up integration of verbal answers by constant directive questioning on the same subject. We also found that contact with Braille gave much more confidence to him, so we later on required him to outline his oral reports. He became visibly embarrassed with flushed face, twitching muscles, and partial vocal cord block if unable to think out an integrating sentence promptly in an oral discourse. Here again, this Braille outline helped him considerably. Noting during laboratory exercises that his hands and mouth were quivering, the instructor attempted to hold his hands, so as to help him work out simple movements, such as required in finger dissection of plants, or feeling of physical apparatus; but he trembled more than ever with increased emotional instability and seemed to lose complete power of controlled muscle coordination. Parathormone and calcium treatments were suggested for these spasms. We found that he showed less nervous tension when one of his blind confreres was directing his hand movements. He tried to show courage when brought in contact actually with the various specimens of the animal kingdom. Visible evidence of repulsion was gradually overcome by forcing the student, without any warning whatever, to grasp and manipulate these animals. This student was over-anxious in everything that he did. He tried harder than any of his confreres, but right in the middle of his best effort he would be quite likely to break down with the tics or nervous twitchings and feel around for help of some kind. Sometimes he went into hysteria to temporarily solve his problems or withdrew himself entirely from his difficult classroom environment. He interested himself in biology after a while and particularly enjoyed field trips on the campus. We found that if we left him alone alongside a tree, for example, he would observe it tactually and learn its characteristics. He seemed to get along better alone, although as the writer has indicated, he made desperate efforts to place himself on parity with his confreres. This student was a typical blind maladjusted introvert. From his recitations and personal quizzing, it became apparent that he lived in a little world of his own which was limited to his sense of

feeling and his auditory sense. He was, however, obviousy interested after a while in some phases of biology and general science; particularly, with regard to plant life. We gave practical instruction in first aid, and all the other blind students got along remarkably well in this work, but student B demonstrated more than ever his utter lack of muscle coordination and kinesthetic sense by being unable to carry out any of the simple lifts, carries, or even roll the easiest kind of bandage. In artificial respiration, he again showed his tendency to lack muscle coordination. By working with him through his blind confreres five or six times as long as the other students, he eventually acquired the rhythm fairly well. This timid student became most nervous when he was aware of the presence of other people. We failed to accomplish much with him except to give him nature study interest, acquaint him with some of the sound apparatus in physics, and help to overcome his inherited nervousness by forcing him to assume obligations during recitations. We could provide but few emotional outlets to relieve his tensions because he could not participate in intramural athletics, sports, or dances; except walking and non-competitive track. Partial ablation of the thyroid gland was considered.

Student C was a diametrically opposite type; he was aggressive and bold in his attitude toward his classmates. He was typically eccentric. He liked to be called upon frequently and expected to do things that brought him into the limelight. If he wasn't called upon with sufficient frequency in the recitation, he would force the teacher's attention to him by asking many questions. His acuity in all of the sense perceptions was high. His muscle coordination was perfect. He walked around the school and classrooms so naturally that it was hard to believe that he was completely blind from birth. He liked biology very well, and was particularly responsive to praise. When the principal came into the room for observation, or members of the school board came to see his work, he showed himself to better advantage than ever, while student B would be trembling and unable to articulate clearly. This student made his own copy models of biological materials, and he made Braille diagrams following the outline of simple structures such as leaves, compressed flowers, etc. Before the members of the school board, he dissected a large bean, opened up the bud of a giant magnolia flower and tactually demonstrated the parts of the cross section of a stem without an error. The more his audience was amazed at his ability, the greater his pleasure became. He made special efforts to keep the attention of his audience away from his nervous confrere, Student B, and that was because he was aware of his friend's handicap. In first aid his ability to grasp manual coordinated movements required in bandaging, putting on splints, artificial respiration, and the demonstration of the lifts and carries was almost perfect. He was able to do better work than some of his seeing confreres. Because of his ability to understand the requirements of his blind classmates, we placed him in charge of the group of blind students and we found that he was much better able to teach them the muscular movements than we were.

The blind can teach the blind. We know that the blind can lead the blind, and we also know that the only real knowledge of the psychology of the blind comes from the blind themselves. People, even trained psychologists, with vision can never appreciate thoroughly the blind person's mind. Mental hygiene for the blind is a very difficult subject to present unless blind psychologists are trained for analytical and adjustment services. Student C accomplished more in the mechanics of first aid with Student B, than any of the teachers were able to accomplish. However, student C had to be taken off by himself where he did not assume there were any seeing students or teachers to observe him critically. The writer stood at some dis-

tance and observed the instruction, and he noticed some of the awkwardness and nervousness of student B disappear under the tutelage of his blind friend. This youngster achieved success in physics also. He could connect up electric batteries, work the wheatstone bridge, set up sets of pulleys, connect up and work electric buzzers with a key in order to learn the Morse code, work some of the mathematical problems connected with force, work, power, etc.; and feel the magnetic lines of force when demonstrated with iron filings, tactually demonstrate the parts of a model steam engine, feel and name the parts of a dissected automobile motor, work problems of flotation and buoyancy, and mastered the unit of sound better than his seeing confreres. In general science, because we told him that he could not master the chemistry unit, he demanded the right to tackle it. The valence blocks described in the article on "Chemistry for the Blind," originated with his determination to do some real work in this subject. His olfactory sense enabled him to identify several well-known compounds, such as acetic acid, ammonia, dilute acids, ether, chloroform, turpentine, etc., the fumes of sulfur dioxide, chlorine, etc., tactually identify copper sulfate crystals, charcoal, magnesium sulfate, cobalt nitrate, sulfur, mercury, etc., recognized by sound the ebolution of gases, recognize simple chemical changes, tell concentrated sulfuric acid by the weight of liquid in bottles, estimate the temperature and heat evolved from neutralization experiments with acids and bases, put together equations using the Bryan Valence blocks which were Braille labelled, interpret models of atomic structures, etc. Chemistry became a vitalized problem for solution to this blind student and his achievements in this socalled "impossible subject" placed him in the upper quartile of the class. Continuous growth as a modern concept in secondary education certainly applied to this well-adjusted student. He was, moreover, free from morbid expressions and introspections which tend to plague some maladjusted blind persons.

Student C demonstrated clearly the laws of compensation in the blind through pleasure in accomplishment, recitation, demonstration of his acuity, and above all, his marvelous knowledge of music. He asked the writer to listen to him play the piano and amazed the writer, as a music lover, with his marvelous technique and perfect hearing in his piano playing. The reason he wanted the writer to hear him was that he wanted the writer to speak to the principal of the school so that he might play before the student body at assembly. The supreme pleasure of his scholastic career, as far as the writer could see, was his pleasure at the applause accorded him after his piano recital. This student still corresponds with the writer. Despite the fact that he was blind congenitally, objective methods worked better with him than subjective. He was more interested in actual contact with all kinds of plant and animal life and technical equipment forms than with didactic descriptions. He was an example of the blind extrovert. He took pride in accomplishment and seemed proud of the fact that as a blind student he could excel many of his seeing confreres in academic and manual accomplishment. Psychologically, he represented complete control of the frustrations common to the blind to the extent that his sight handicap was an asset rather than a hindrance to his social and academic success through the best defense mechanism—sublimation.

Student D was another representative type. Apparently, from his early childhood blindness he had been taught through life adjustment education, because of his handicap, to regard everybody as his willing aid. He expected that everyone who came in contact with him would cater to him sympathetically and regarded help from everybody as his inherited right to make up for his sight deficiency. He expected the teacher to devote more time to him than to anybody else. He was quite

bright and extraordinarily ambitious. The psychological adjustment to his sight loss was answered in his insatiable thirst for knowledge. Spinster women appear to seek adjustment from the normal maternal instinct in women by meticulous attention to detailed work, and they expect everybody around them to do the same thing. This possibly explains the reason why some spinster principals, supervisors, or department heads are intolerable in their attitude toward young teachers. They expect these young teachers to give up all their pleasure and social engagements in order to take care of all sorts of ridiculous, unnecessary, detailed school procedures. Student D, following the laws of compensation, adopted a course similar to that of the spinster women. He got a lady in a night school class of read German to him. Once having gained her desire to help him, he expected her to come around to his house and read daily to him, irrespective of the sacrifices involved. He encroached on the women's time so much that she came to the writer for advice, for she couldn't bring herself to accept pay for her services from a blind man. She found the time requirements an inexorable burden to her. Student D asked the writer to assign a reader in biology and general science for him. Later, the reader begged for relief in that he could never satisfy the insatiable craving for knowledge of student D in the two subjects. Student D expected to be waited on continuously. In general science he expected special instruction, and the writer had him come out to his house on several occasions in order to help him. Once he had secured the writer's interest, he called me all too frequently for suggestions and advice. Finally, the writer indicated to him that real success would come to him when he tried to work out his own problems. The writer further indicated that success in student D's case necessitated less dependence upon his readers and instructors, and more self-reliance in solving his own problems. He was obviously chagrined, and he stayed away from school for one week, during which time he did not get in touch with any of his readers or friends. When he reappeared, he handed the writer a large package, which upon opening the writer found to contain a beautiful hand turned netted hammock, which he had made himself. He tried to solve his own problems from that time on and made Braille outlines of all his lessons. He made good in college and graduated with honors. His compensation, the writer repeats, for his loss of sight came through high educational ideals and achievement goals, such as a college education, keeping his mind occupied with all accumulating sorts of interesting information, and acquiring new skills. This philosophically minded blind student did not allow himself to become an introvert because he occupied his mind with all manner of difficult studies with endless problems for possible solution. When he was by himself, he told the writer, he spent his time recapitulating, or thinking over the subjects that he had been occupied with during the day. He worked his way through school as a piano tuner, and again he enlisted the services of faculty and students with whom he came in contact to help him to get jobs, and he got many charitable responses. The writer assumes that he gradually overcame his overcompensation tendency to be a parasitic pest on those who were willing to work in order to help him.

The student made the remark to a friend of his that there was absolutely no reason for him to be an introvert or lonely. He indicated that, through his education and reading, his greatest friends were numbered among philosophers, authors, and scientists of the past and present. He also indicated that he had no time for introspection and day dreaming mechanisms of evasion, and his life was too full of associations and with those great musical composers and authors, whose writings and creative works were inspirational guide posts for the appreciative intelligencia to

follow. Sublimation best describes this student's victory over his blindness.

Student E was partially blind, and because he could vaguely visualize or differentiate large objects, less attention was given to him than to those who were completely blind. This did not suit him, and his behavior pattern tended to be intolerant, snobish, antisocial, and antagonistic. He expected to be in the limelight and receive the same guidance as his completely blind confreres. We overcame this difficulty, in part, by giving him more difficult tactual assignments and requiring him to use what sense of sight he had in differentiating biological, physical, and chemical apparatus material. He tried to sidestep oral recitations, and told other blind students that they didn't have to study in biology, that Mr. Bryan liked blind students too much to fail them. This student was actually jealous of those that had complete loss of sight, and they in turn disliked his attitude. The teacher, here, was at fault until he realized the absolute necessity of giving all the blind, or near blind, students exactly the same attention. When student E was called upon more often and asked to demonstrate his skills, he became less objectionable and antagonistic to his confreres. He knew that the others received a lot of help and sympathy on account of their complete handicap, and he, of course, expected no less. He tried to make us believe that his handicap made him as dependent as the other students; however, the writer noticed he led the totally blind from class to class by virtue of his having at least limited sight. This student deserved the same attention as the others, and when he got it, took his place socially and fraternally with his confreres, both seeing and blind. He liked the idea of being a leader of the blind, and he apparently enjoyed assisting in tactual demonstrations of the models and apparatus, both chemical and physical, specially set up for the completely blind students' use.

Students F and G were both partially blind, but they preferred to minimize their limited sight sense handicap, and mix in with the seeing students. They got along extremely well in all their subjects in high school, as the comparative achievement charts will show, both socially and scholastically, becoming a normal integral part of the school life. One of them won successive wrestling bouts in his weight class and won the championship of a large high school—beating all his seeing, as well as blind, opponents.

These cases are cited to indicate the diversity of psychological differences, both adolescent and adult, to be met with among the blind, or partially blind, high school students. It reiterates the point brought out so clearly by Dr. Cutsforth, that only the blind can appreciate and comprehend blind psychology. Methods of instruction have to be adapted to meet the needs of the blind adolescent, based on observable mental characteristics.

The retentive powers need to be trained to the highest degree of efficiency in the blind students. The blind student has fewer special senses to impress in his mind the things he needs to remember. He relies upon the retentivity of his memory very much more than the seeing students. The student with sight can consult books, diagrams, pictures, dictionaries, encyclopedias, and further, has a much greater opportunity for conversational queries with authorities in the subject in which he is interested. Psychologically, it is surprising how much a person in possession of sight retains his mental pictures through direct visual impressions. It is commonly stated, "I never forget a face," although the person fails to recall the name. The student will rely entirely upon the sound of the voices of an individual and associate it with a person's name. This is just one example where the blind person is forced to use his retentive powers and train them by constant repetitions in his mind in order to remember or recall things for his own use.

We, who see, write down a memorandum for engagements, dates, obligations, etc. The blind student has to train his mind to remember them, because he could not always have his Braille set on hand. We rely upon a thousand and one visual aids, both technical and mechanical, that make it unnecessary to memorize or work out what we need to know. The blind student has to memorize practically everything; therefore, he is apt to derive a marvelous memory training as an important phase of his educational experience. The results of the achievement tests in several high school subjects and mental tests tend to bear this out. During a lecture on the physiology of the earthworm, for example, the seeing students will see the charts and difficult words written on the board by the teacher, he will observe the diagrams or demonstrations, and possibly copy some of these in his notebook in the course of the lecture or ricitation. The seeing student is quite likely to have mental lapses (daydreams) during the course of instruction, failing to concentrate on the project. Stop in the middle of a sentence and ask adolescent students in possession of their sight the preceding words or get them to write them down, and examine them. One is quite apt to find 30% failing in this concentration test. The blind student, trained to concentrate on the sounds of words and sentences, interprets and memorizes them without visual imagery, and will usually prove that he is at least attentive and reacting favorably to the didactic presentation.

The proof of the average blind student's ability or tendency to concentrate on didactic presentations has been deduced from the results of frequent oral tests by the instructor. The blind adolescents appear to be able to reconstruct a thought or lesson aim better than their seeing confreres, due possibly, to less distraction. Seeing students look out of the windows, gaze at the pictures on the wall, note the idiosyncracies of the teacher, gaze at the girls in the mixed class, etc., while the blind tend to be motivated largely by their auditory sense.

The blind outside of the classroom, however, tend to weave the most distinctive mental fantasies around themselves. They are the center of their spatial sense. Student X dictated an interesting theme on his field trip, based entirely on his sense perceptions.

He said: "I enjoyed my ramble in the country. I felt comfortably warm and the wind blowing was just enough to rustle the leaves and twigs, and the sound was soothing and pleasant. I walked over many winding pathways and had to turn many times as I brushed up against wet, scented branches of the trees and bushes. The road was rough and I stumbled over the rocks, so I found it better to walk on the grass which bounded the pathway. The grass was knee high, because I could feel the blades brushing my legs; but sometimes I got tangled with thorny briars. The thorns protect the plants, but they cut into my skin, so I had to walk more cautiously. Buzz, Buzz—yes, that's a busy bumble bee. He must be looking for that sweet scented honeysuckle which smells so nice. He seems to be puzzled; not knowing just what flower to visit, judging by the way his excited buzz is heard all around me. I wonder too, if those crickets ever get tired of chirping. Just in front, then behind me, he goes. The birds must be very happy today, judging from the way they are chattering and singing in the warm sunshine. The trees keep getting in my way; in addition, I can't feel the hot sun on my face, so I must be in the woods. The rough bark of this tree, the nice piney odor, and the feel of the long needles proves that I am feeling a pine tree. I will feel around the base of the tree and try to find some pine cones. They should fall near the tree. I felt one under my foot, because I could feel it crunch as I stepped on it. Yet, it's a pine cone. My teacher told me to bring in specimens. I'm glad I found one myself. These big leaves near me on this low lying branch are smooth with round finger ends. I picked some of these on the City College campus; they feel like the oak leaf. But this tree is just a sapling, because the trunk is very small and I can almost feel the top of it. The ground is very soft and comfortable and easy to walk on. I am walking on a carpet of fall leaves. I picked some up and they feel brittle and damp. When I tripped over the roots of some tree, my hands came in contact with a soft, fresh, cottony mass of plants with a delicate soil odor. They feel fuzzy. I think I have fallen on some moss. I didn't hurt myself, and I'm glad there is a soft moss carpet to fall on. These woods smell so nice; I feel so comfortable that I'd just like to lie down and sleep on these pleasantly soft surroundings, and no

wonder the babes in the wood were content to sleep there. I am coming to a stream; can't you hear the bubbling and gurgling of the bouncing water as it tumbles and ripples over the rocks? The sound is varied all the time and is very soothing. Again I'd like to find a leafy, mossy resting place and go to sleep lulled by the music of the stream, the birds, insects, and rustling leaves. Yes, the woods are very comforting and makes one enjoy being out of doors; and my friend the bull frog has just croaked his agreement."

This reaction of a sightless naturalist to his rambles in the woods suggests a new and workable methodology for oral discourses to class of blind students. The instructor should use, as far as possible, only analogies and reference that come within their realm of comprehension and understanding. Why tell a blind student in chemistry that the brilliant phosphorescent glow emanating from burning magnesium ribbon identifies the substance. This terminology is meaningless to him. Rather mention the heat involved, and the hissing sound as it burns. Such statements are intelligible to him.

In biology whole textbooks have been Brailled recently, but in physics and chemistry little effort has been made in this direction. The blind students, when they go home or to the resident blind school, have readers to present their assignments to them. The writer has recommended that these students take Braille notes on important topics in all their subjects, even when a reader is covering an assignment for them. If the blind student keeps a Braille notebook and uses this as a means of review and an aid to memory, it is surprising how well such a student of average mental ability is able to compete with the seeing members of his class in an objective examination. The blind live in a world of recalled mental pictures and obscure images without visual distractions; hence their relatively high standing, despite their handicap, even in subjects like biology and general science, which require more than the usual amount of visual impression.

Among the special psychological problems connected with the blind which have to be considered and utilized practically in helping the development of the mentality and intelligence of blind students are: first, the Eidetic images or residua of impressions that he is able to reconstruct from percepts acquired before losing his sight. Eidetic images do not exist in those blind from birth unless conjured up in realistic dreams which they can retain. Then comes the question as to whether or not students blind from birth can dream so that Eidetic images can be formed. This is a doubtful question. Images and impressions in the blind must apparently be built up from tactual, oral, or olfactory experiences. The author's questionnaire indicates that the majority of students not blind from birth can recall the various colors and objects such as trees, plants, animals, houses, ships, automobiles, locomotives, and even difficult things, such as typewriters, mechanism inside of clocks, carburetors of automobiles, and recently, even television sets, etc. This image retentivity is necessarily dependent upon the length of time they have been blind and their chronological age. When such students lose their sight they psychologically reconstruct old experiences and reinterpret new experiences from the sensory perceptions left them, utilizing particularly their auditory and tactual senses coupled with their kinesthetic sense of movement. There is thus a direct recall transfer in the use of tactual models and specimens, for instructional purpose in the sciences. For those that are born blind the problem is much more difficult, as they live in complete darkness bounded by the limits of their movements and by varied sounds which emanate from space around them.

Gestalt psychology propounds the theory which necessitates the blind student's acquiring a full mental image of the objects of his environment as a whole. The unaffected senses partially compensate for the deficiency of perception in his lost vision. The practical application of this Gestaltism is that it cuts down considerably the visual

vocabulary of sightless persons. The paring of the visual residua depends, as previously indicated, mainly on the age at which blindness sets in.

Adolescent psychology of the blind, if it could be worked, would be extremely interesting in its application to the teaching of high school biology to blind students. What arouses their emotion, their sex instincts? To what extent does fear, uncertainty, and doubt enter into the minds of blind students? From a biological standpoint it will be seen that according to the questionnaire sent out by the writer blind high school students show little fear of live animals. They evidently prefer live snakes, turtles, grasshoppers, clams, fish, and cats to pickled specimens and majority of them would be interested in learning tactually the internal anatomy of small animals. Then, once becoming tactually familiar with animal forms and internal organs, they tend to lose their sense of repugnance. Some of the live animals that the seeing students dislike to handle such as mice, worms, snakes, lizards, etc., the blind students, on the contrary, show no antipathy for. This is an interesting phase of their psychological reaction, for in the inhibitive or fear complex, repulsiveness for some of the more loathsome animals is less accentuated in the blind. It appears that the tactual sense is less likely to occasion fear, dislike, or repugnance, than the visual sense. On the contrary, however, unusual or discordant sounds are particularly objectionable to the blind. In the physics lab, where harsh notes are struck on the sounding board, or the tuning fork reverberates too noisily, the blind students show visible nervous emotional responses. The blind are quick to criticize unpleasant enunciation or rasping tones in speakers or teachers. They prefer modulation of the voice and soothing tones. It is also noted in the questionnaire that the blind students who have had biology or nature study lose their fear and repulsion for the lower animals, including invertebrates and vertebrates, simply by virtue of scientific or avocational interest. The instructional necessity or acquisitiveness in having to come into contact with, and study these various animals and appear brave before their classmates helps materially.

Illustration: Blind student B visibly shuddered when first brought into tactual contact with a live wriggly earth worm. However, his fear of appearing scared before his classmates forced him to overcome the repugnance. The day writer dropped a pickled octopus into his hands, and he displayed interest instead of inhibitive fear, satisfied the writer that instinctive tactual repulsion can be overcome, if only motivated by interest and interpretative understanding.

Another absorbing problem in psychology is the visual vocabulary, for it is obvious that the blind student must have a limited comprehension of words directly related to vision. The distinctive vocabulary used in biology has to be built up in the blind students as well as in the seeing student. The achievement tests show that the blind student is able to grasp biological and chemical nomenclature as well as the average seeing student. The questionnaire again helps us in finding a solution to the color vocabulary as it is interpreted by the sightless individuals. The color problem is dependent entirely upon the length of time that the student has been blind. If the student has been blind from birth, it is very questionable if he has any color perception at all. The only possible color perception in these students would be materialized in their dreams. The questionnaire seems to indicate that they get color perception in dreams, but this conclusion seems to be doubtful according to Jeanne E. Chapman, Superintendent of the Washington State School for the Blind.

The psychological reactions following the "laws of compensation" in the blind are important. The remarkable development of the tactual, auditory, and olfactory senses as compensatory measures are, of

course, too well known to require exposition. The blind students' unnaturally restricted universe needs to be enlarged educationally via his remaining senses. All methodology in all subjects of instruction depends partly upon this doctrine of compensation. Biological instruction, which includes recognition of plant and animal structures, is taught largely through the tactual sense following oral description and readings; chemistry and physics, through both tactual and olfactory sense perceptions of chemicals, apparatus set ups, etc.

In conclusion, psychologists have agreed that the blind are entirely educable. Learning can take place through the tactual and auditory senses.

Mental ability tests are valuable to blind students if given in the same ratio, as such tests prove valuable to seeing students in order to determine their intelligence quotients. Once the IQ's are determined, homogenous groupings can be attempted and provisions made for individual differences in adapting courses and subjects to meet varying needs. The writer made a set of questions in Braille, but it became instantly apparent that this method of evaluating or testing mental ability would be unfair and untenable. The facility with which the blind student can read Braille, is dependent upon his adaptability, training, and the number of years of blindness, and is thus subject to individual variations. Therefore, the best method of giving a mental ability test to the blind is to dictate the questions orally. The examiner should study the achievement test carefully first and experiment with the time for presentation and the time for answers. Next, he should work out a time period for answers and speed of reading of each section of the test. Finally, a reading instructor should sit beside the blind student and record his answers.

While six blind students in a mixed class of 40 normal youths cannot represent a large enough group to make a strictly comparable study possible, yet it is interesting to note the relative standing that the blind students hold in reference to other members of the class with regard to data obtainable from mental ability test results.

Abnormal psychopatic intelligence or emotional deviate cases among the blind are infrequently met with in the high schools, because the scholastic elimination processes of low IQ's solves the problem. Superior ratings among blind students in mental ability are not unusual in high schools, because the low blind IQ's gravitate to blind industrial schools for their training when such students are near high school age. The mental ability tests show a fair coefficient of correlation with achievement in high school sciences. In addition, the achievement of these blind students in other subjects of the high school curriculum is decidedly above the average. The writer has gone over the report cards, achievement ratings, and retardation lists with the respective subjects teachers of these blind boys, and he has found that the standard of achievement is relatively high. Subjective ratings and gradings, however, will be partly influenced by the teacher's sympathy, which will have some bearing on his marks. This leniency toward the blind is particularly true in the academic subjects, such as English, history, civics, commercial law, ancient and modern languages, where the teacher, cognizant of the difficulties and obstacles encountered by the blind students in working up detailed assignments and projects, make due allowance for the handicap. Furthermore, there is the encouragement concomitant with high marks which keeps the students motivated and interested in high achievement ratings in all his studies. In science and mathematics with the teaching difficulties involved, special methods of instruction should be adapted to the use of the blind student. The writer has indicated how the problem of science instruction is being met with, particularly

in general science, physics, biology, physical geography, geology, and chemistry, where special methodology has to be worked out in order to meet the needs of sight handicapped groups.

There are certain sections of the standard mental ability tests based on visual comprehension that are scarcely adaptable to blind students' use, and these should be deleted. The writer was interested in making comparative studies of the mental ability of blind students as compared with seeing students. Only six blind students could be used in this study, which immediately presented a problem. Standardized tests must be given to all participants in exactly the same manner if the tests are to measure mental ability for comparative data when the time element, attitude of the examiner, and physical conditions must necessarily be the same for all those being examined. Only one method of examination appears to be feasible for comparison of seeing and blind students, and that is, as previously stated, the dictation method. The examiner should prepare in advance for the dictation, because the speed of reading, and the time allowed for each answer should be the same during the presentation of each section of the test. The test arbitrarily selected in these experiments as being most adaptable to blind student use was the Terman Group Test of Mental Ability, Examination Form A, for grades 7 to 12. To demonstrate for immediate reference the comparative mental abilities of the blind students as compared with the seeing ones, bar graph charts were prepared in which a bar corresponds to the ratings of intelligence attained by an average class of students in biology.

Relative blind pupil achievement in biology and physics was evaluated by giving standardized tests which were dictated to the entire class, and recorded in a similar manner to the IQ tests. Interpretive readings of charts show that the relative achievement of the blind student compares favorably with the seeing student. In studying the records and grades of the blind students in other academic subjects, it was observed that the ratings as a whole were higher than those of the seeing students. Testing programs for intelligence in the blind were given in the Perkins Institute for the Blind in Overbrook, Pennsylvania, and also in Baltimore, Maryland, under the direction of trained psychologists; nevertheless, in spite of this work, to quote from the 10 Year Psychological Research in the Schools for the Blind, a statement was made that "experimental psychology of blindness is an untilled field." The testing program for intelligence should include the Binet Scale for the Blind, but in addition, the regular intelligence tests can be modified, as previously suggested, to fit the needs of the blind students, though some of the parts which depend entirely upon visual perception will have to be eliminated.

The blind students, in place of the usual diagrams, used clay models, three-dimensional models of the actual specimens, and were required to find and name the parts just the same as the seeing students did visually. The problem here, however, was obvious. It took a blind student much longer to tactually locate organs, parts, etc., than the seeing students whose perception here was instantaneous. Students with sight can see the organ or part as a whole, while the blind students have to run their hands all over the organ or part before they get a spatial sense of the entire structure. Therefore, the only equitable method of comparing laboratory achievement a skill, was to require no time limit when conducting the blind students' laboratory achievement tests.

At the time of writing, there are three blind students enrolled in the public high school, Baltimore City College. Two are seniors, and both are in the Honor Society, which means that they had a scholastic average of over eighty for the past two years. Their grades, which are based on objective

and subjective tests, are interesting, because the range of subjects taken show the typical spread expected in seeing students.

Biology	85 – 88
Physics	77 – 78
English	85 – 84
French	85
Geog.	85 – 85
Econ.	90 – 90
Latin	88

These marks place them in the upper quartile of the senior class and in the top ten per cent of the entire school enrollment of 2,000 odd students.

The junior student takes some of his work at the local school for the blind, but in the public high school he is on the honor roll also, with grades of 76 in English, 79 in history, and 80 in physics. It will be inferred that these three blind students, while representing a select group with "I.Q.'s" of over 110; nevertheless, they have adapted themselves to working with the seeing students so successfully that their handicap is scarcely observable.

The pedagogical exception to the complete adaptability of the blind to the liberal education available in junior or senior high schools is mathematics, including algebra, geometry, trigonometry, commercial arithmetic, bookkeeping, and arithmetic. These subjects present many difficulties requiring individual instruction and special methodology, best presented by special teachers for the blind in resident schools.

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GENERAL SCIENCE FOR THE BLIND

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REHABILITATION OF THE BLIND THROUGH SECONDARY SCHOOL SCIENCES. General science, as taught in junior and senior high school, is an ideal introductory subject for the blind, after completing their fine specialized preliminary training in state resident schools for the blind. In the majority of high schools, little attempt is made to teach any phase of general science by individual laboratory work. The method of instruction consists largely of teacher demonstrations, recitation, and reports, supervised study, and occasional class problems or exercises to be done as seatwork.

Living as we do in an advanced scien-

tific atomic age, some elementary knowledge of all the major sciences is essential for adjustment to modern living conditions; and the blind are not exempt, for they too, meet daily problems of a scientific nature in their routine existence. The average conversation includes discussion of a scientific or semi-scientific nature, and the blind, trying to fit into the world of the seeing, needs general science knowledge so that he may meet on a social and cultural level with the seeing.

Practically every boy or man has some pleasurable avocation or hobby which involves science, such as: photography, insect collection, model airplanes, jet propulsion, chemistry, radio, radar, electricity, etc. The handy man around his home can fix the radio, wire a doorbell circuit, oil the refrigerator motor, change and clean spark plugs in the car, trim the grape vines, make some rose cuttings, read the barometer, forecaset the weather, feel the pulse, treat a burn or cut, mix paint or varnish, use a hand lens, thread pulleys correctly, put in a fuse when the lights go out, spray fruit trees, and many more.

Efficiency in meeting everyday scientific problems comes from training and experience. If we consider the topics that are taught in general science, it will be seen that the average course comprehends answers to all of these questions. The elements of biology, chemistry, physics, geology, magnetism, electricity, weather, astronomy climate, steam, and hydrostatics are units included in the average general science course of study.

Junior or senior high school general science serves as the introductory course to all the other specific sciences. The subject should be made interesting to the average pupil. Unfortunately for the blind, interest is secured largely through visual aids in teacher demonstrations. Observe the reactions of a junior high school science class seeing for the first time the pleasing experiments connected with the preparation and properties of oxygen. The average boy or girl is breathless with interest if the teacher motivates the experiment with enthusiasm and effective presentation. The blind student in class wants to be thrilled too, and science can be made vital and interesting if the teacher gives some thought to his particular needs, and the problems resulting from sight handicaps.

Remembering the axiom that the blind may be taught satisfactorily through the remaining sense perceptions of touch, taste, hearing, and smell, it is only necessary to adapt instruction which utilizes these senses to greatest advantage.

The tactual and auditory perceptions, because they tend to be keen in the blind person, may be trained to appreciate scientific facts. One general pedagogical rule for blind science instruction involves the tactual observation of all demonstration apparatus. If a duplicate set is available, it is wise to have a careful and bright seeing student sit with the blind boys and guide their finger over the apparatus, while the teacher is didactically demonstrating or presenting the topic. The teacher should be careful to include the blind students in every discussion, and by directive thought, provoking questions, a sustaining of their interest in the topic can be obtained. Braille diagrams, cut-outs, relief models, etc. can be used just the same as those mentioned in biology books, whereever the subject matter makes them applicable or helpful instructional aids.

The seeing students keep a science notebook which is a record of all the experiments undertaken and it is written up in accordance with directive thinking and problem solution. The blind student might keep a Braille notebook also, and, as a check on accuracy, be required to read parts of it to the class, or perhaps to the teacher alone for criticism or discussion. The usual procedure in preparation of the Braille notebook will be the same as for the seeing students. On the top of the page and then down it will usually appear like this: (1) the title of the experiment;

(2) the object of the experiment; (3) the apparatus used with a Braille or cut-out diagram if necessary; (4) the operation (how the experiment is performed); (5) observations which may be tactual, auditory, or possibly olfactory; (6) conclusion —what the experiment demonstrates or proves; (7) applications—what practical utilitarian value this experiment has or how it is used in modern science or industry. The blind can make tactual observation and draw conclusions satisfactorily, if the set-up of the experiment is simple, and large enough for spatial and relationship concepts to be formed.

The first lessons in general science usually deal with the air, proving by experimental deductions that air occupies space, has weight, and exerts pressure. The air concepts can be taught the blind for they can feel the wind blowing on their faces and feel directed air under pressure blowing on them through a tube, and as a practical example, allow them to blow up a balloon and note how the air pressure will eventually burst it. In the lesson devoted to creating a partial vacuum to demonstrate external air pressure, allow the blind students to work the vacuum pump and then get them to try and separate the Madgeburg Hemispheres. After exhaustion of the air, ask them why the hemispheres can be separated when the faucet is opened and the air let in. Why does a light bulb explode when dropped? Let them feel the balance arm fall when air enters an electric light bulb by puncturing it with a blow pipe flame. They should feel the cavity of the rubber sheet stretched across a bell jar as the air is exhausted from inside it and also the hole or rent following the loud explosion rupturing the rubber sheet as the air pressure of 15 lbs. per square inch is exerted above the sheet covering exhausted air in the bell jar.

The barometer story will probably have to be presented largely by description and feeling of the barometer. If the blind students have been up in an airplane or on a high mountain they will particularly appreciate the decreased air pressure as the elevation is increased. The conventional current topics can be adapted to blind student needs by simple devices. Let them stand over the vent of a hot air heating plant. Is that draft, the warm air rising? Why do we hear the roar of a furnace? Note that the writer is using descriptive terms appreciated by the blind—"hear the roar," "feel the warm air," "feel the air pressure," "hear the rustling of the leaves," "smell the smoke rising."

The air unit may be followed by the water story. The blind can easily appreciate that water is heavy. Let them lift a beaker containing air. Then fill it with water and lift again. (The cubic foot concept can be taught by a series of blocks). Next, let them feel a half pound weight. The concept that the cubic foot of water weighs 62½ lbs. will then have kinesthetic meaning for the blind student. Permit the blind students to pour water into two connecting open dishes and then feel the smooth water surfaces proving that water seeks its own level. Have a blind student try to cork a bottle filled with water with the cork pressing on the surface of the water. Why does the cork shoot up all the time? Can water be compressed? Guide the blind student's finger as he feels the hydraulic press and pumps up the small cylinder himself. Why does the heavy weight rise over a large cylinder with such easy motions of the pump lever? The blind student may drop a weight into a container of water and feel the water rise because the water is displaced. Why does the water rise when one enters a bathtub, and why is it possible to support the entire weight of the body on the little finger in water? Suggest that the blind students try this at home and report on it the following class day. If an object is felt floating on the water surface, how much water does it displace? Let the blind fill an aquariam to the top with water. Why does the water run over when a toy

boat is floated in it? How much water overflows? Yes, it is the weight of water displaced by the floating boat. The blind students, from these tactual demonstrations, will enjoy the story of Archimedes, involving the principles of floatation and buoyancy.

Teaching distillation and condensation to the blind, involves tactual manipulation of the unheated apparatus. They may feel the cold water circulating over the condensation chamber and note tactually the distillate as it flows out. Water circulation may be taught by an impression diagram drawn on a flat, soft clay surface. The blind should be familiar with the sound of boiling water and be cautioned about coming near any warm or steaming objects. Ice floating in water makes a good tactual demonstration for the blind. They might try to estimate the amount of ice first above and then below the surface of the water. Should the teacher put on the board a diagram of a commercial ice plant, some keen seeing student might prepare a simple cut-out diagram of it, and while the teacher discusses the function of each part of the plant, the blind might get a tactual perception of the cut-out or model. If recitation is called for, the effectiveness of this tactual lesson might be tested by asking a blind boy to discuss orally the ice plant construction and operation. The home assignment might include the writing up of a Braille report on the ice plant and, in addition, pasting in their notebook the labeled Braille diagram.

Having studied air, water, convection currents, dew point, thermometry, and the barometer, etc., the story of the weather follows. The barograph and thermograph may be tactually demonstrated, provided the blind boy's hands are guided so as not to damage the indicator or spill the ink. The seeing students usually have an exercise, a weather map to draw showing the isobars and the isotherms and also the cyclonic areas, highs and lows, etc. The blind need not be excluded from this valuable lesson provided some clay is available for a relief map model. The isotherms may be represented by the grooves across the map and the isobars by string or wire imbedded in the clay. Cut-out maps strung across the strings, will also serve the purpose of demonstrating weather maps to the blind. Sometimes, a socialized recitation fits nicely into the weather unit and in the case of the blind, they should be called on frequently to take an active part by presenting oral reports, using Braille notes if necessary. It is a good plan to have a blind student take charge of the class in order to give him the confidence which tends to come with social responsibility. The wind force can be demonstrated to the blind by asking them to note the feel of the wind and hear the rustling of leaves, twigs, and branches according to the inintensity of the wind. The part played by the radio weather reports will appeal to the blind as another utility for their home radio or TV set.

The biological units in general science can be taught by field trips in which the blind are brought in tactual and olfactory contact with as many varieties of plants and animals of economic or esthetic interest as possible. They can identify trees by smell and touch of barks, leaves, seed, fruits, and flowers. In microscopic work, clay or plaster of paris models may be made by interested technical students for tactual demonstrations and Braille labeled by the blind students themselves. The blind should also have some tactual familiarity with stems, roots, bulbs, corms, etc. particularly those that are edible.

Zoological studies are as interesting to blind boys as botanical studies are to the handicapped girls. Tactual study of invertebrates such as porifera, corals, echinoderms, mollusks, anthropods, crustacea, etc. are ideal vehicles for blind students who usually get much pleasure out of identifying these animals by their anatomical characteristics. Comprehension of the vertebrates particularly birds and mammals by their notes and cries, may be a pro-

tective measure when visiting farms, or on field trips.

Human physiology is extremely interesting to the blind, and with the wonderful dissection models on the market of the entire skeleton, torso, heart, ear, kidneys, reproductive organs, and others, they enjoy immensely trying to put them together, the blind need no longer regard the human body as a mystery, but as something tangible and understandable to them.

Modern high schools and colleges offer a wealth of curricular material available to the blind, and all the blind need are teachers who are sufficiently interested in their problems to work out special methods adapted to their world of darkness.

Science hobbies of interest to the blind include mineral, fossil, sea shell, and leaf collections.

Through science training in high school or college, some attractive vocational opportunities are suggested to the blind. They may train for assembly line or storekeeping jobs requiring manipulative skills, as sound recording, sonic device, radio, or telegraph code operators, piano tuners, or as greenhouse floriculturists.

Professional fields are open to the blind as teachers of elementary science in resident blind schools, as instructors in rehabilitation centers, or schools for the handicapped, where remaining sense perceptions may be used to advantage.

"Lighten our darkness we beseech thee, Oh Lord." "The Lord is my light and my salvation." Psalm 27.

A NEW LOOK AT THE LIFE OF LOUIS PASTEUR *

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THOUGH now called a genius of science, Pasteur's early years were not marked by exceptional ability in science nor by any high grades in school. His life is the wonderful story of a man developing his abilities by hard work and constant study toward his goal.

However, Pasteur had an almost wonderful power of devoting himself completely to his research and science. For days, even weeks, he lived in the laboratories, working on the problem before him. His method of solving scientific problems was a slow, thorough one, to which he devoted himself completely. Every job which he undertook had the benefit of his complete energies. Teaching, crystals, ferments, and all of the others were mastered as a result of persistent efforts and his undaunted enthusiasm.

The word "enthusiasm" is found throughout every story of his life and with good reason, for the word very aptly describes one of the reasons for his success. Perhaps the best example of this was his determination to locate information on tartar; the search carried him through Europe at his own expense.

His personal life was no less admirable than his scientific life in many respects. The story of his life is full of such words as "patriotism," "loyalty," "love," and "devotion," to family and strong moral fibers, and they became very definite descriptive adjectives of the Father of Modern Medicine.

His scientific achievements followed in almost systematic sequence. Early in life he taught mathematics which gave him accuracy, and later chemistry, and the crystals in chemistry. He followed this with a study of fermentation which gave him reason to question the theory of spontaneous generation. The disproof of this theory led him to work with germs as applied to diseases. He and Robert Koch

separated the bacteria according to disease, and Pasteur began his life-saving work of immunization.

YOUTH AND EARLY SCHOOLING

In studying Pasteur, the man as well as the scientist, it is of interest to note his heredity.

Louis Pasteur's father and grandfather earned a living by the tannery trade. Jean Joseph Pasteur was drafted into Napoleon's army at the age of twenty, and had distinguished himself in the capacity of a soldier. During the three years in the army, he rose to the rank of sergeant-major in the Third Infantry Regiment. This regiment was known as "the bravest amongst the brave" because it was often outnumbered in battle. He earned the Cross of the Legion of Honor, an honor which he later was to see his son receive, and was discharged after Fontain Ebleau. He loved and was devoted to his country, and passed the love of country to Louis. As the wonderful story of his life unfolds itself, it is of interest to see just how much of his work was devoted to improving France's industries and health.

The mother of Louis Pasteur was Jeanne Etientte Roquie, a gardener's daughter. The Roquie family was known for their strong affection to their kin. All information concerning the marriage of Jean and Joseph seems to indicate a happy one which gave the to-be scientist a helpful environment.

However, they were opposite in nature, since Joseph was described as being "reserved, almost secretive, with a slow and careful mind," while she was "very active, full of imagination and ready enthusiasm." During his life, Louis had nothing but praise for his parents who considered his education as important as the necessities of life. His family lived in the simple dignities of life.

Louis Pasteur was born Friday, December 22, 1822, at Dole. There was nothing colorful nor any indication of genius in young Pasteur as one might expect, for he was known as an average pupil. It is partially for this reason that the story of his life is so thrilling, because here is the so-called conscientious slow student justifying his existence to an extent hardly paralleled by any other men. Certainly it is nothing more than a day dream for a young man to hope to live a life so full of achievement as Pasteur. Does it not make the slower student feel that perhaps his purpose in life may be more than his report card indicates, especially if he has the power of incessant work and concentration?

As a young child he played in the yard of his father's tannery. It is almost amazing that Pasteur's early interest should be in the field of art rather than natural science. Here was the boy destined to mature into the Father of Modern Medicine painting pictures. He doubtlessly acquired this interest from his father, who at one time painted a picture of a discharged Napoleonic soldier tilling the soil. Louis, too, painted a portrait of his mother, which had considerable merit. He was evidently a sensitive child, because he objected to hunting and disliked seeing injured animals.

The headmaster of Arbois College, M. Romanent, had a profound effect on the life of the young boy. M. Romanent found in Louis the enthusiasm and careful mind which others had failed to understand. He encouraged Louis to prepare for entrance into the Ecole Normale.

Ecole Normale Superrieure was founded in 1808 by Napoleon I for the purpose of training young men for professorships. In order to qualify, it was necessary for a student to be between the ages of eighteen and twenty-one, and pass one written and one oral examination. He must already have had a bachelor of science degree. The next five years of his life were devoted to preparing for entrance into the great French school.

Preparation began at the age of sixteen, but he soon met his first and probably last major failure. He and his friend went to a Paris boarding school, but Louis's heart was not in the work, because he suffered almost constantly from homesickness. He longed for the smell of the tannery and the love of his home. His father, having been notified of the condition, brought Louis home. Here again one can visualize him as a rather reserved, sensitive child.

At home again, no doubt discouraged by his recent weakness, he renewed his interest in art by pastel drawing. He also studied in the local college, Arbois. Like the struggles of anyone's life, his failure in Paris was soon compensated for by the fact that he was doing very well at Arbois. M. Romanent encouraged the young pupil again to prepare for Normale by attending the near-by college at Besancon.

At eighteen, he took the degree of "Bachelor es Lettres" with a rating of "Good" in most of his studies and "Very good" in science. Despite the only average grades of his degree, he was offered the post preparation master, and accepted. In addition to teaching, he studied and set about the task of rectifying the weaknesses which caused his first failure. His thinking was greatly affected by the writings of M. Droz, a moralist who advised "moderation as a dorm of wisdom and an element of happiness, and that most men sadden and trouble their lives by useless worry and agitation." It was now that Pasteur laid down the basic philosophies which he was to exercise during his life.

Still not prepared for Normale, he went to Paris, with a lifelong friend, Chappius. He was required to pay only one-third of the fee because he taught younger students mathematics. Pasteur was not fond of this subject, yet admitted its importance and from it acquired accuracy. After a year of strenuous study in such subjects as physics, chemistry, and philosophy, he was admitted fourth on the list for Ecole Normale. It was indeed a great day for the young man. Thus one sees how he gradually worked his way to the famous school.

During all of this schooling, Pasteur wrote frequently to his family telling them of his progress; and in return, he received from his father and mother praise for his efforts. He was always grateful to them for giving him the opportunity to study. At twenty-one he entered Normale, "equipped with an integrity of character, an ability to learn, a love of good literature, and the loyalty of family, friends and teachers."

STUDY AT ECOLE NORMALE

Louis was so eager to enter Normale that he arrived several days early and volunteered to instruct M. Barbet's students in physical science in appreciation for the help he had given him. Here, Louis led a vigorous life of study in the classes and on his own in the library and laboratory. Now he was in competition with the most brilliant students in France, and had to work vigorously to compete with them.

Those who knew him at the time remember him as grave, quiet, almost shy, but under this was superior enthusiasm. There is nothing to indicate any sense of humor with Pasteur at all. His nature was definitely serious, and he went about his work with a cold, sober, attitude.

A few months after being admitted, he heard a chemistry lecture on the process of making phosphorous and, not being content with the explanation, went to the laboratory to try it himself. He burned bones, treated the ashes with sulphuric acid, and extracted some phosphorous. This incident perhaps sounds very common to us today, but it must be remembered that in that time there was no such thing as a student being required to perform experiments. As a matter of fact, the laboratories in even the most up-to-date schools were very small makeshift rooms with few

pieces of equipment and were mostly for the use of the professors. In later life Pasteur rectified this condition.

In addition to his studies, he did a great deal of research in the small laboratories on a subject which had challenged scientists for some time. He was interested in finding some information on paratartaric acid, or racemic acid, which was very rare. His professors had been unable to find anything definite about the rare acid. In connection with this work, he became interested in the researches of an officer of the engineers, Etienne Louis Malus, who found that light reflections of the crystals could help in analyzing the properties of many substances. It was with a polarizing apparatus that he hoped to seek the properties of tartaric acid.

On the "license" examination, he ranked seventh; and on a competitive examination in physical science for fourteen students, Pasteur was third. The slower mind was gaining ground on the more brilliant students. Pasteur's interest in science was not like most of the students who studied to do well on the final examination because his prime interest was the application of science in the laboratories. Slowly he was offering even the best students a good race by his incessant efforts. His fellow-classmates often ridiculed him because he spent so much time in the laboratories and at hard work. His one good friend throughout the entire schooling was Chappius, who was deeply involved in the study of philosophy and yet had a blind confidence that his friend would make a success of science.

Most of the professors admired Pasteur and expected him to make a success as a teacher. M. Balard, who discovered bromine, took Pasteur as his personal chemistry assistant in the laboratory. From this the young scientist gained very valuable experience. In this capacity he had the good fortune to work with another noted scientist of France, Auguste Laurent. At one time the Minister of Public Instruction wanted to send Pasteur to a small school to teach elementary science, but M. Balard blocked the move on the grounds that the young student was more valuable in the laboratory. Through M. Balard, Pasteur met M. Biot, one of the most respected French scientists of the time.

When Biot, then seventy-four, heard of the work on racemic acid, he listened with some scepticism. After Pasteur performed his experiments in the presence of Biot, the scientist was deeply touched. Thus, the young man won a powerful friend by demonstrating that some crystals reflect light to the left while others reflect it to the right. With such men as Biot and Balard to encourage him and abetted by his own relentless efforts in experimentation, he became noted in the scientific world for his research in chemistry.

TEACHING

After relentless work, he acquired his doctorate of science and was now obligated to serve ten years teaching in public schools. His first assignment was a rather dull one for the young enthusiastic laboratory scientist, for he was sent to teach physics at Dijon Lycee, an elementary school. The job was difficult for Pasteur because he found it very hard to arouse the interest of listless students. However, like any other problem which he took on, he devoted himself completely to the job. His research was stagnant during this assignment, because in order to prepare the lectures, he had no free time for other work. He wrote to his friend Chappius, "I find that preparing my lessons takes up a great deal of time, and it is only when I have prepared a lesson very carefully that I succeed in making it very clear and capable of compelling attention." M. Biot and other professors objected to the Minister of Education for having Pasteur in an elementary school. As a result, the education department promised Biot that Pasteur would be given the first possible opening in a college. Pasteur's friends were indeed loyal to him.

Two years later the clouds of gloom had lifted, and his life was a pleasant one at the University of Strasburg as assistant professor of chemistry. Here he taught older students and smaller classes. What was even more important, he had time to pursue his researches. Moreover, he had the friendship of his old school friend, Bertin, professor of physics.

Four months after his arrival, the young scientist and educator married Marie Laurent, daughter of the Rector of the Academy of Strasburg. He met the Laurent family (not the scientist earlier mentioned) upon his arrival at the university and immediately enjoyed the simplicity and gaiety of the household. In Laurent's family he found all the love and peace which was typical of his own home and early life. Marie well realized the responsibilities of a professor's wife and was willing to have him put his laboratory work before his home. Pasteur felt that she was an ideal wife.

The years that followed were happy for Pasteur. He devoted himself to improving his abilities as a teacher during the school term while spending the summer doing research in chemistry. The results of the experiments were read annually to the Academy of Science, much to the approval of Biot, who felt that Pasteur threw light on everything he touched. He kept in constant contact with Biot whom he greatly respected.

January 3, 1853, was an important day in the development of Pasteur, the scientist, because the academy devoted an entire session to this work. Surprisingly enough, it was not for the work for which we know him today. Most of the lecture was devoted to his production of racemic acid from tartar. The work involved the use of his previous knowledge about crystals. That is, the crystals from some acids reflect light rays to the left and others to the right. The discovery would seem elementary to us today, but at that time it excited the scientific world.

His discovery was not without ardent effort, however, because he traveled throughout Europe to locate the information he needed. He spoke to chemists who mistakenly thought they could produce racemic acid directly from tartar. The Paris Pharmaceutical Society was so interested in racemic acid that a prize of fifteen hundred francs was offered to anyone who could produce it for manufacturing purposes.

A NEW METHOD OF TEACHING SCIENCE

Pasteur's name had now become associated with scientific achievement, and he was asked to undertake a job of great importance. The Minister of Education asked him to become dean and professor at Lille, a school of science. It was a new school, built at the expense of the local town Faculte.

As the still young man of thirty-two spoke at the opening of the school, the listening students witnessed a great change in the teaching of science. Prior to Pasteur's science college career, there were apparently no facilities for the students to carry out research and experimentation of their own. Now, however, he made it plain to the students and the country that young men would learn the relationship between theory and practice. The importance of this move may seem small on first consideration, but the average layman of the time saw none of the applications of science to solving the problems of industry and health. In his opening speech, Pasteur said, "Where will you find a young man whose curiosity and interest will not be immediately awakened when you put into his hands a potato, when with potato he may produce sugar, with that sugar alcohol, with that alcohol ether and vinegar?"

Afterwards he went on to uphold the importance of theory by saying, "Without theory practice is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. And thus, gentlement, a theoretical discovery has but the

merit of its existence: it awakens hope, and that is all."

Pasteur's school soon became respected as the most progressive in France. He was meticulous about preparing his lectures on chemistry, and his students were delighted when he took them on tours through factories and foundries in France, Belgium, and the cities of Aniche, Denain, Valencienness, and St. Omer.

In connection with the method of teaching science, it appears that perhaps Pasteur's new teaching might well have contributed to the industrial revolution because here was the closing gap between academic science research and the actual production of domestic products. Industries could now profit by the college graduates of science to a greater extent. Moreover, young men were better equipped to earn a living with their theory and practice schooling.

FERMENTATION

Two years after assuming charge of the school, a seemingly small incident led to an almost complete change in chemistry and further led to the revolution of medicine. A Lille manufacturer, M. Bigo, came to Pasteur greatly disappointed by the failure of his beetroot alcohol. He and other manufacturers of beetroot alcohol had met failure and felt that Pasteur could help. The interest aroused by fermentation in the population of Lille was so intense that he consented to do a great deal of work in that field.

The gist of his work was the observation that when globules in the fermentation juice were examined under the microscope, the healthy ones were round, lengthened when alteration began. He was very careful about releasing information until he had successfully proven it many times. From the above hypothesis, he and his students were able to make observations during the various stages of fermentation.

Prior knowledge on fermentation was very small, and no definite explanations had been offered. After three years of work on the subject, Pasteur released the fact that ferment was caused by an active microorganism. The discovery not only aided M. Bigo and the alcohol industry, but began an entirely new train of thought.

Many years later he became interested in the problems of France's wine industry. Pasteur proved that the wine disease was caused by an active ferment, and after many experiments, demonstrated that the wine could be rendered free of disease by boiling it to a temperature of 55 to 60° C. Most people were skeptical of the work because they feared that the taste would be affected. He lived to see the wine industry adopt his method.

Still later in his life, he did similar work with beer with much the same conclusions. The German beer industry had far surpassed the French, and it was for this reason that he undertook the work. It is interesting to note that the word "pasteurized" was first associated with beer.

Fermentation was of the greatest importance to the world because the knowledge of it laid the ground work for all subsequent investigations on microbes.

THE BATTLE AGAINST SPONTANEOUS GENERATION

During the time that he did his first researches with fermentation, Ecole Normale was very poorly organized. Rehabilitating the old school was Pasteur's next job. It was far from being a pleasant job, for the morale of the school was low; and the students had little interest in studying. What was even worse, was the fact that Pasteur had no place to carry out his experimentation, which was at the time, on the fermentation of milk. However, with his usual enthusiasm, he went about the task of improving the school, and soon the students took more interest in study.

In his attic laboratory he pursued his work on fermentation and attempted to disprove the theory of spontaneous generation. M. Biot advised his former student against

this because of the complex nature of the problem. M. Pouchet was the chief believer in the theory, and he and Pasteur exchanged arguments on the subject quite frequently. Pouchet maintained that microorganisms were created by the air and wrote a paper known as "A Note on Vegetable and Animal Proto-organisms Spontaneously Generated in Artificial Oxygen Gas." From his previous work with ferments, Pasteur had reason to doubt this theory. Pasteur wrote to Pouchet that the theory was "not founded on facts of a faultless exactitude." He further thought it was "whole and untouched by decisive proofs."

Thus began the controversy of Pasteur and his carefully analyzed facts on spontaneous generation. The argument was another challenge for him, because he knew he would be required to provide very decisive proofs in order to convince the world that the long believed theory was incorrect.

In order to settle the point, Pasteur devised an experiment so simple anyone could understand it, so clearcut it was impossible to refute. He filled flasks, which had long necks, with a microbe food. He boiled the food to kill any creatures which might already be alive, and then let in air. All the germs and dust could settle in the neck of the tube while only pure air would reach the food. M. Bouchet would have expected germs to be found on the food, but there were none. Thus, air alone could not produce germs. When the germ food was brought into contact with the flask's neck, microbes or germs were found in quantity.

He made other experiments with the air, such as testing air for the presence of germs at the top of Mt. Poupet in the Alps and in cellars. By reducing the argument down, Pouchet soon had no scientific grounds on which to speak.

The advocates of spontaneous generation agreed to hold a meeting, and members of the Academy of Science would decide the issue. Pasteur presented his experiments as proof, while the others failed to give any evidence to support their theory. Moreover, Pasteur gave lecture-demonstrations to large popular audiences at the Sorbonne. At last Pasteur sighed and said, "Never again will the doctrine of spontaneous generation recover from the mortal blow of this simple experiment." Thus, with Antony Leewenhoek's invention of the microscope, Robert Koch's work with bacteria growth, and Pasteur's practical experiments, the theory of spontaneous generation was refuted and the road to modern medicine was open. Pasteur's later work and gifts to mankind were all to come from his researches on fermentation and germs theory.

SILKWORM DISEASE

An old science friend, M. Duman, asked Pasteur to come to southern France to help find a prevention for the silkworm disease which was running rampant in that area. Thousands were dependent upon it for a living, but now the industry was at a stand still. People who were once gay and happy now walked the streets in hunger and despair.

He took leave of the Normale and traveled to the stricken area. Because he knew nothing about silkworms, he began to read on the subject. His first intention was to find the source of the disease, rather than anything which would immediately cure it. The farmers became impatient with his slow, methodical work and demanded action. He continued to study thoroughly the problem and began a healthy colony free from the disease of pebrime. He decided that disease multiplied rapidly because the diseased moths passed it to their young. The disease was caused by a definite microbe and could be best prevented by using only the healthy moths. His conclusions were correct; but another disease, flacherie, had invaded the silkworms.

During this work, his happiness was interrupted by the deaths of both his father and daughter. He wrote about him as fol-

lows: "When I was young he kept me out of bad company and gave me the habit of work and the example of a life absolutely loyal and incessantly occupied."

His heart was heavy, but he continued to live a life "incessantly occupied and absolutely loyal." While waiting for the moths to hatch, he studied cholera, but with no apparent success.

When he returned to his work with the second disease, he was stricken very ill with paralysis and nearly died. For many days his life hung in the balance, but gradually, as though he had more in life to accomplish, he recovered with only a slight limp resulting from the illness. He returned to southern France and eventually outlined a method for preventing the two diseases. Pasteur met with much opposition and even unscrupulous jealously, but nonetheless, the job was well done and was another merit to the great scientist. As a result of this work, he won the favor of the Emperor, and the Sorbonne received a new laboratory. A great deal of Pasteur's time was taken in explaining his research to both popular and industrial audiences.

GERMS AND MODERN MEDICINE

All of his previous work was leading up to one thing: germs cause disease, and they can be controlled. Following the Franco-Prussian War of 1870, which temporarily set back the progress of French science, the appalling number of soldiers taken ill with gangrene attracted the study of Pasteur. It was now that Pasteur was able to apply his principles to solving the causes of human diseases. He was greatly honored, in this connection, by being elected a member of the "Free Associates of the Academy of Medicine."

Work with gangrene was also being carried on by Joseph Lister, a very excellent English surgeon, who had demonstrated that by sterilization of instruments and bandages, and by exercising extreme care in operating, the possibility of disease could be greatly reduced. He wrote Pasteur that he had applied the Frenchman's principles in his hospital with great success. As the result of the efforts of these two men, we can now enter a hospital without fear of contracting a disease as the result of an operation.

The opposition to Pasteur's idea that the doctors and nurses were carrying the diseases from patient to patient was very great at first. However, the fact that those using the Pasteur method to modify their surgical treatment was beginning to convince doctors the world over.

Thus we see that Pasteur's discovery that fermentation and putrefaction were due to the minute living organisms led him to investigate the conditions under which these micro-organisms existed, and their connection with disease. He presented practical problems to illustrate that gangrene was caused by a specific microbe.

Though in 1843, Oliver W. Holmes had published a paper on the "Prevention of Childbed Fever," in which he told of the importance of cleanliness in handling patients, people were still dying by the thousands of the disease. Semmelweis had made similar observations without any definite conclusions. Pasteur, however, isolated the microbe, and set about the task of convincing the doctors to exercise extreme care before delivering a baby.

An English physicist, Robert Boyle, two centuries earlier, had made the statement that he who could probe to the bottom of the nature of ferments and fermentation would probably be more capable than anyone of explaining certain "morbid phenomena." The physicist was very correct too, for two centuries later Pasteur had explained the nature of ferments and was now going on to explain many "morbid phenomena."

CURE FOR MORBID PHENOMENA—IMMUNIZATION

The next disease which Pasteur undertook to study was probably one of the most important, because it illustrated the

use of immunization. Robert Koch had succeeded in isolating the microbe of anthrax and growing them in an outside culture. The disease was becoming very expensive to France, because many sheep were dying of the disease, which threatened to destroy a great industry. Pasteur found, after a great number of experiments, that by vaccinating the sheep with a weak virus solution of anthrax, the sheep would receive only a mild attack of the disease, and then be immune. This was very similar to Jenner's smallpox vaccination.

Despite his many previous successes with fermentation, silkworm disease, gangrene, and all of the others, he met much opposition from other men. As with the spontaneous generation theory, the argument was to be decided by experiment in public. The scene of the experiment might well be compared to a tournament of knights in the Middle Ages. The arena was a pen with two segregated groups of twenty-five sheep each. Half were to be inoculated by Pasteur; the other half untouched. Later, the two groups were to be injected with the anthrax germ.

The two knights were about to clash now, and public tension mounted as the day of decision arrived. Pasteur's reputation as a scientist hung in the balance.

The results were another triumph for Pasteur, because the twenty-five unvaccinated sheep lay dead or dying while the other group was well and healthy. His practical experiments were bringing a new medicine into existence.

His final achievement and the one which attracted the most public attention, was his work with hydrophobia. This disease was an insidious one of human beings, and was caused by the bite of an infected dog. Prior to Pasteur's work, the disease took the lives of thousands; because of his efforts, it is now rare.

After a year of study, he arrived at the conclusion that the rabies virus attacks the nervous system. He later discovered a vaccine for preventing the disease in dogs. It was obtained from the dried brains of dogs, dead with hydrophobia. He was confident that he could render dogs immune from rabies, but was doubtful about inoculating human beings. Now he had what he considered his greatest personal challenge.

A young child, Joseph Meister, was brought to him with many bites of a mad dog. Encouraged by his scientific friends and realizing that the boy would die unless he did something, he began his fourteen-day treatment. The first virus was very weak, but each day it was a bit stronger, until finally, the boy received the full strength. Days of personal unrest for Pasteur followed the treatment as he awaited the results.

The boy lived, and the news echoed around the world with the result that many people came to Pasteur for treatment.

As a result of this, a Pasteur Institute was founded primarily to treat hydrophobia, to carry on further research, and to teach Pasteur's methods.

It is little wonder then that Pasteur, by public plebiscite has been acclaimed the greatest Frenchman of all time—greater even than Napoleon or Victor Hugo.

SAMUEL JOHNSON AND EXPERIMENTATION

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In his scholarly volume on Samuel Johnson, Krutch said Johnson ". . . wrote in flaming indignation concerning those experiments on living animals which his age, under cover of the astonishing Cartesian theory that animals could feel no pain, practiced with almost unparalleled coldness and wanton triviality." Although no one aware of life then or now will deny the occurrence of cruelty and barbarity in our own day, it is regrettable that neither Johnson nor Krutch cited specific instances justifying their respective verdicts.

Johnson began his brief essay of Saturday, August 5, 1758, No. 17 in *The Idler,* by twitting weather forecasters and "Idlers," one of whom "passes the day in catching spiders, that he may count their eyes with a microscope; another erects his head, and exhibits the dust of a marigold separated from the flower with a dexterity worthy of Leeuwenhoeck (sic) himself. Some turn the wheel of electricity; some suspend rings to a loadstone, and find that what they did yesterday they can do again today. Some register the changes of the wind, and die fully convinced that the wind is changeable."

These "Idlers," says Johnson, ". . . may claim some indulgence; if they are useless, they are still innocent; but there are others whom I do not know how to mention without more emotion than my love of quiet willingly admits. Among the inferior professors of medical knowledge, is a race of wretches, whose lives are only varied by varieties of cruelty; whose favorite amusement is, to nail dogs to tables and open them alive; to try how long life may be continued in various degrees of mutilation, or with the excision or laceration of the vital parts; to examine whether burning-irons are felt more acutely by the bone or tendon; and whether the more lasting agonies are produced by poison forced into the mouth, or injected into the veins."

The learned doctor also declared, in typical unrestrained, and unreasoning anti-vivisection fashion, that "There are men yet more profound, who have heard that two colourless liquors may produce a colour by union, and that two cold bodies will grow hot if they are mingled; they mingle them, and produce the effect expected, say it is strange, and mingle them again. . . . but the truth is, that by knives, fire, and poison, knowledge is not always sought, and is very seldom attained . . . I know not, that by living dissections any discovery has been made by which a single malady is more easily cured." What Johnson did not know apparently had no existence, and that he could scoff at chemical experimentation is surprising:

Yet Krutch said, ". . . Johnson really shared the contemporary interest in chemistry," and since he defined an idler as "a lazy person, a sluggard," and said the word amuse is ". . . frequently taken in the sense of contempt," it seems strange that he could speak of experimenters in this way. Among the British men of science immediately preceding and including Johnson's time, were such men as Wharton, Willis, Ray, Hales, Crew, Hooke, Monroe (primus), the Hunters, Cavendish, Priestly, etc., and even Cruikshank, whom Johnson once had recommended to succeed Dr. Hunter.

Since every normal person has abundant opportunity to infer that domestic animals are endowed with a sense of pain, and since Ray (1627–1705) had rejected, if not disproven, the self-contradictory Cartesian theory of the insensibility of animals to pain, as Wharton (1610–1673) had upset the Cartesian hypothesis of the pineal seat of the soul, it seems highly doubtful that the

British men of science of Johnson's day, were misled in their attitude toward animals by Des Cartes. Furthermore, if the latter held that animals are guided by instinct and subjective sensations, his conclusion regarding their inability to feel pain probably did not carry much weight with men of science and reflection.

Since Johnson defined a cruel man as one "pleased with hurting others" and cruelty as "inhumanity, savageness, barbarity," his charge against men of science plainly was that of sadism. It is true that he levelled his accusation especially against some "inferior professors of medical knowledge," . . . "a race (sic) of wretches," etc., but in the absence of specific names or data, this cannot absolve him from the guilt of gross misrepresentation or ignorance.

Johnson's peculiar use of the word race strikes one's attention and recalls Boswell's reference to the "race" of "Bostonians" for whom he had no kindly feelings, but who, he felt, should be given a fair trial and not merely be judged by their "character," in regard to their attitude toward taxation.

No informed person will deny that animal experimentation, in preanesthetic days, as docking, dehorning, castration, for convenience or taste, and fishing and hunting for pleasure, involved suffering. But when the "Great Moralist" charged that animal experimentation was done merely for amusement and that those so engaged were guilty of wanton cruelty, and held that all experimentation was useless save as it amused, he clearly revealed that "solitude" had failed to deliver him "to the tyranny of reflection", to which he said few people submitted themselves. Moreover, the preliminary words "I know not" cannot excuse his ignorance regarding the importance of experimentation for the welfare of mankind. Indeed, in this matter Johnson spoke quite as ignorantly as he did when he called the pastern of the horse, the knee, but unfortunately with far greater possibility of mischief.

No one acquainted with life will deny the occurrence of cruelty in the past or in his own day, but this does not prove that it is due to sadism. Yet, the great English lexicographer's mistaken attitude was shared by his contemporary Joseph Addison, who wrote in 1711, when medical quackery was so rampant: "Innumerable retainers to physic, who for want of other patients, amuse themselves with the stifling of cats in an air pump, cutting up dogs alive, or impaling insects on the point of a needle for microscopical observations; besides those who are employed in the gathering of weeds and the chase of butterflies, not to mention the cockle shell merchants and spider catchers." Surely enlightenment grows slowly especially among antivivisectionists who, to be consistent, should not seek the help of surgeons who learned how to operate on human beings by operating on animals.

IS H_2O THE ANSWER TO THE "H" BOMB?

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THE threat of the "H" bomb hangs over our own heads! True, embryonic tests place us slightly in the lead in the race toward destruction, but can the Soviets be so far behind? Recall the rapid acquisition of the "A" bomb by the U.S.S.R. Vulnerability—therein lies the tragedy, for it is we, not they, who have retained our productive centers within highly concentrated areas. The decentralization of the U.S.S.R. under way for more than a decade, has contributed to their advantage despite our vastly greater productive capacity for we remain vulnerable despite any defense.

We must decentralize if we are to survive. Yet where are the voids into which we can expand and mitigate the devastation of this threat to the United Nations? What feasible places remain for occupancy that can be occupied in a true spirit of democracy?

Few portions of the earth have such great potentialities for occupance and agricultural production as do the arid lands if only water is available. These are commonly the lands of abundant sunshine whose soils have been little leached by rainfall, and whose barrenness frequently is attributable largely to thirst. At present the earth's arid lands, though encompassing nearly one-fifth of the total land surface, only sparsely support in meager fashion a scant four per cent of our globe's rapidly expanding population. If semi-arid lands be added, then the total land surface harassed by excessive evaporation is far greater. A major portion of these dry lands lie outside the sphere of Soviet control but until quite recently mass migrations into these lands have largely proved futile as well as costly in lives and toil. Today the dream of making deserts bloom is being brought into reality by recent developments in the synthesis of extremely thin plastic membranes from coal-tar and petroleum chemicals. These "permionic" membranes have the remarkable capacity of demineralizing seawater without heat or chemicals—a practical and relatively inexpensive process of de-salting ocean water in vast quantities so that it may be turned upon the land for bounteous crop production as well as the production of useful minerals.

Despite civilization's great advancement, man's very existence is still largely tied to production from the soil. Unless large portions of the desert voids on the maps of agricultural production can be changed to producing areas, our planet's rapidly upsurging population seemingly must sometime reach a suicidal fringe. True, the most dire aspects of such population pressure may be postponed by increasing production through improved agricultural techniques. Surely though, these must eventually reach a peak of decreasing returns for effort expended.

Perhaps our technicians can perfect methods of retarding our population growth, but any such solutions must await many decades for ultimate success. Meanwhile, the expansion of economical crop and animal production onto our rather barren areas of today would be a God-send. Through chemurgy, a goodly portion of the greatly increased crop production could be employed for vastly expanded industrialization to meet many of man's needs other than subsistence. Perhaps this might even so lessen man's bitter competition with man that a peaceful era could be achieved.

Not only could agricultural production of the arid and semi-arid areas be increased many fold, but large portions of present humid lands could double their production through controlled irrigation as well. Such has already been demonstrated innumerable times by existing examples of irrigation within the humid realms. One profitable enterprise exemplary of the many employing this idea is the 20,000 acre Birdseye Food Corporation farm located in humid New Jersey where vegetable production has been doubled through irrigation in proper amounts at just the right time.

With even the brief consideration above, the concept can surely be grasped that desalted ocean water, made available in adequate amounts at reasonable cost, would be a momentous achievement. Not only would this be true for agriculture alone, but the ever increasing consumption of water by industrialization expands the signficance of this matter to a still greater magnitude.

With the perfection of this practical process of utilizing sea water virtually completed, we are now faced with the challenge of seeing that it be used to the greatest welfare of all mankind. This has been at least partially realized by our law-

makers who have instigated congressional action toward the rapid deployment of its benefits in association with our point four viewpoint. Over a period time this would greatly relieve our supporting role in regard to the "have-not nations" and so raise their living standards as to instigate trade of mutual benefit to all.

In fact, abundant water supplies from the oceans may have quite revolutionary effects upon the economies of many peoples and nations. The breadth of the potentialities of this matter has so many facets and ramifications as to fall largely beyond the comprehension of any one person. Yet it should be realized by all that herein lies the basis for many monumental changes within the societies of large portions of the earth. Changes which can perhaps aid in the alleviation of the use of atomic power as a threat, and instead employ its vast reservoir of energy to pump and process these newly available waters far into our continental land masses. Just how far inland it will be feasible to pump these waters is dependent upon many variables, and must be left to the determination of the technicians. Yet there seems little doubt that water can easily be made available to numerous coastal plains and considerable distances inland where mountain barriers do not intervene, and the rise in elevation is only moderate. Perhaps even the mountain barrier may present only temporary obstacles through the construction of huge tunnels such as the gigantic Thompson water diversion project of the Rockies in Colorado. Areas of high alkalinity may also present problems as to whether it would pay to utilize vast quantities of water to flush these lands before any production is obtained from them. Other problems will undoubtedly arise, yet few, if any, seem insurmountable at present.

One wonders just what migrations of population may result when waters are suddenly made available to thirsty lands formerly regarded as of little value. In many areas, real estate speculation may run rampant in such fashion as to make the Florida land boom seem comparable to the Alice in Wonderland tea party. Yet despite this undesirable aspect, many worthy persons may at long last obtain a goodly portion of mother earth to call their own. In fact, our land settlement patterns may be so changed by major population migrations as to result in vast depopulations of our major urban centers. This could involve considerable decentralization of industry as well. Such decentralization could greatly devaluate the use of the "H" bomb as an offensive weapon. Quite probably also many of the benefits advocated by the decentralists may well be obtainable and even the more visionary viewpoint of Frank Lloyd Wright and his school of decentralists might come into the fore.

For the many who may desire to secure worthy sites in the van of mass migration, and to do so without an intervening speculator's fee, it seems highly desirable to make a few directive suggestions. To persons reared in humid climes, the proper analysis of arid land sites is not an easy task. Unlike humid lands, arid regions all bear the stamp of conformation to arid conditions, and therefore areas of greatest potentialities are frequently not outwardly discernible. The neophyte in desert travel is usually soon heard to remark that it all looks quite the same and rather barren at that. For such persons, random selection of even minute portions of land in this newest frontier could prove futile and costly. Yet if only four relatively simple though detailed tasks are undertaken, even the desert novice can adequately prepare himself for considerable worthwhile field survey work. This can culminate in the securing of excellent sites of great worth to himself and his lineage.

The four tasks constituting a minimal training program for those unfamiliar with desert exploration are: first, the preparation of a large and quite detailed sketch map of the arid region or area in which a site is to be selected; secondly, an adequate

consideration of the most suitable time for a field survey, and the best methods of travel to be employed; third, the attainment of a broad understanding of arid land peculiarities and inherent characteristics; and fourth, the acquisition of fundamental skill in the use of a plant index chart appropriate for the area under consideration.

Each of these training tasks can bear further scrutiny. The prime purpose of the preparation of the large detailed sketch map is to provide a base upon which pertinent information can be correlated and relationships made visible at a glance. Much information can be compiled on this base map which would otherwise be hidden and neglected within many pages of print. For example, such items as general drainage patterns which would directly affect gravity-flow irrigation; large areas of high alkalinity; and some of the best temporary, if not permanent, routes of travel can frequently be plotted in considerable detail from information already available about the area. Mayhap even those tracts can be indicated which possess dangerous site characteristics such as those subject to the devastation of infrequent but violent flash floods. The more detailed this base map can be without becoming so cluttered as to be a maze, the more useful it should prove. Perhaps if the area under consideration be large, several sectional base maps may be advisable. Valuable information for these maps is obtainable both from other maps and prose decriptions of creditable validity. The mapped area should also be considered in relation to pumping distance from a major salt water source.

The second step is the adequate consideration of the most suitable time for field survey work, and the best methods of travel to be employed. Improper time for field work may negate the use of a most valuable tool—the plant index. Whereas a selection of the proper time or times can greatly facilitate the use of the existing plant cover as a most reliable indicator of site characteristics. For example, widespread areas of specific plants in blossom can frequently provide readily visible evidence as to the expanse of soils and soil conditions. Also, the time and season of travel may have considerable to do with easing the ardors of travel. Travel by air, wheeled vehicle, or pack animal each has its particular advantages but decisions as to use should all be weighed in terms of cost, speed, and probable accuracy of results. This matter is certainly worthy of considerable study before final determinations are made.

Vicarious acquisition of an understanding of arid land peculiarities and inherent characteristics even with thorough study is not the equivalent of first hand experience. Yet without wide reading of arid land descriptions and studies, field work had best not be attempted by those not previously arid land occupants. Even with abundant preparation many problems may prove difficult of solution, though not insurmountable. It cannot be over-emphasized however, that without the guidance of someone well versed in the exigencies of the desert, only very short traverses should be attempted.

The wisest selection of any arid land sites is closely tied to a judicious use of an appropriate plant index. A few key plants such as sagebrush or creosote bush in rather solid stands can indicate a soil free of harmful alkali and readily usable for agricultural purposes if the site is suitable and moisture is provided. Excluding such exceptions as these, generally when native plants tend to group themselves to the exclusion of nearly all other species or tend to gather in certain plant combinations, rather reliable evidence is provided of some peculiarity of soil or site conditions. Thus, a study of plant cover affords an invaluable index as to many existing conditions whose ascertainment and analysis would otherwise be quite costly. Properly understood, native plants in deserts will provide amazing amounts of

PLANT INDEX CHART

I. NORTHERN DESERT SHRUBS (SAGEBRUSH)

Name of Plant	Index of General Soil and Site Characteristics	Index of Amount and Quality of Alkali Content	Index of Usability for Irrigation	Index of Usability for Dry Farming or Grazing
1. Small sage	Indicates a shallow and often impervious soil.	Low in alkali.	Nonagricultural.	
2. Scabland sage	Insufficient soil to grow sagebrush.			
3. Little rabbit brush	Usually found in deep loamy soils.	Ranges from low to medium salt content but commonly free from harmful amounts.	Often indicates areas where sagebrush has been eliminated by drought or burning.	
4. Bitterbrush	Usually found on sandy, volcanic, or rocky soil.			
5. Coleogyne	Grows where soils are loose, rocky, or sandy.			
6. Chamiso	Indicates sandy land in both northern and southern desert areas.			
7. Shadscale	Commonly dominates much of the more level and mature soils of sagebrush desert. Fine textured soils. (See column 3.)	Harmful amounts of alkali at a depth of one to two feet. Luxuriant growth of this plant indicates dangerous amounts.	Land in which plant grows best is usually light and free from alkali in top foot or so, but underlain with heavier soil. May be reclaimed by flooding in some cases.	Commonly unfit for dry farming.
8. Salt sage	When seen as a low mat cover with much bare surface, it indicates soils that are heavy and highly saline even at surface.	(See column 1.) Highly saline.		
9. White sage	Ashlike soil. (Also see column 2.)	Alkali at a depth of 10" to 1'. Plant not alkali resistant but when grown to exclusion of sagebrush and other non-resistant plants, the lower depths either high in alkali or underlain with hardpan which prevents deep root growth.	Conditions indicated in column 2 make general farming undesirable with probability of alkali. Soil often rather impervious—reclamation difficult under these conditions.	

10. Winter fat	Soils vary considerably, but frequently of fine texture.	Some alkali commonly at one to two feet.		Generally indicates land suitable for crop production without irrigation. Excellent grazing land.
11. Galleta	Soils usually pervious, of light loam or sand loam in texture.	Free of harmful amount of alkali.		Good grazing land.
12. Giant wild rye	Characterizes richer, more moist alluvial bottoms in sagebrush areas—a good judge of the best soils and best conditions of soil moisture in these areas.	Free from alkali.		
13. Sagebrush	Pervious soil, moistened to several feet depth.	Free from alkali.	Good agricultural land under irrigation.	Successful dry-farming in average or better-than-average years.
	II. SOUTHERN DESERT SHRUBS (CREOSOTEBUSH)			
1. Creosotebush	Occupies alluvial fans, deep pervious soil; stony, shallow soil when plant has poor growth.	Free from harmful amounts of alkali.	Usable when properly handled.	
2. Saltbush	Transition from dense stands to thin stands marks change from a heavy rich loam soil to pervious sandy or rocky soil.	Small amounts.	Dense stands indicate fine textured soils containing some salt but not sufficient to injure if cultivated properly under irrigation.	
3. Mesquite	Solid stands indicate good soil of considerable depth with ample available water—probable soil water moving slowly beneath trees or water table there.			
4. Narrowleaf saltbush	Heavy, compact subsoil with lighter surface layer of 4" to 8".	Small amount in surface soil, over 0.5% in subsoil.		

(Continued on next page)

PLANT INDEX CHART

II. SOUTHERN DESERT SHRUBS (CREOSOTEBUSH)—*Continued*

Name of Plant	Index of General Soil and Site Characteristics	Index of Amount and Quality of Alkali Content	Index of Usability for Irrigation	Index of Usability for Dry Farming or Grazing
5. Giant cactus	Usually on soils sufficiently rocky to anchor superficial root system.		Usually too rocky.	
6. Chamiso	Marks sand ridges.	Heavy alkali beneath sand ridges.		
7. Sacaton	Commonly on best alluvial bottoms.	In bottoms, free from harmful alkali.	Indicates best soil and natural moisture conditions as giant rye does in northern desert area.	
III. GREASEWOOD (SALT–DESERT SHRUB)				
1. Greasewood	Subsoil well supplied with water.	More than 0.5% salt.	Not productive under cultivation without leaching.	
2. Greasewood and shadscale	Usually heavy soil.	Alkali within one or two feet of surface.	Non-agricultural unless leached.	
3. Seepweed	Water table near surface or surface seepage.	High alkali at surface, frequently 2.5%.		
4. Pickleweed	Moisture throughout growing season due to water table near surface.	Highly alkaline, usually 1% to 1.5%.		
5. Samphire	Moist soil.	Considerable alkali.		
6. Saltgrass	Moist soil.	Rather high alkali content, little of it less than 1%.		Valuable for grazing when drainage of fresh water onto these lands after rains.
7. Alkali sacaton	Heavy land, moist to surface, commonly in wet bottom lands.	Contains about 0.5%.		One of the most edible grasses of the desert.

information as to: wind erosion; approximate alkaline content of the soil and its location in reference to the soil surface; depth of the soil; drainage conditions; soil moisture content and depth of same; areas having greater amounts of water available, including possible permanent supplies of underground water; probable capabilities of the land for agricultural use; former land use involving burning, overgrazing, or previous irrigation; soil structure and texture, etc. Such items as density of plant cover, mounding of plants, lines of more vigorous vegetation, and partial burying of plants also have a story to be read by those who understand. A more complete comprehension of the value of plant indexes can perhaps be gained by examination of the accompanying sample plant index chart prepared for three types of deserts in western United States. A more detailed chart of this sort adapted to the particular area under consideration should be prepared by all who would obtain the most advantageous desert exploration. Adequately prepared, a plant index chart can prove to be one of the most useful and reliable of all sources of information in the analysis of our parched lands.

Only a decade ago Paul B. Sears' book "Deserts on the March" appeared in print. The volume was directed toward the solution of all of our mounting conservation problems but the title was certainly prophetic of civilized man's amazing increase in water consumption within recent times. Even as this is written, news reports proclaim the widespread droughts in the "humid" coastal states of southeastern United States. Yet these states are adjacent to vast Atlantic and Gulf sources of salt water. Certainly fringe areas bordering these great water bodies would find an influx of such waters of small cost after de-salting has been accomplished. Moreover, with lengthy growing seasons for crops and year-round pastures in these areas, irrigation with inexpensive ocean water should prove highly profitable. Even the badly scarred and down-trodden areas subjected to the blight of continuous cotton or tobacco can, with ample irrigation and proper management, abundantly produce a protective mantle of green grass. This will place the southeast in an even more highly competitive position in beef production and dairying as well when a suitable Brahma-dairy crossbreed is perfected. In fact, those coastal plains areas throughout the world with long growing seasons, be they humid or arid, may in the quite near future increase their agricultural production several fold. Inland valleys little distance from the oceans may have a similar future though areas further inland will probably undergo some delay in development attributable to the higher costs of importing water greater distances.

Inland southwestern United States is particularly blest in having three major sources of sea water: the Gulf of Mexico to supply Texas, the Pacific to supply inland California, and the Gulf of California to supply southern Arizona as well as adjacent Mexico. If you will examine a climatic map of the world, you will find it quite providential that almost all of the major deserts of the world are either adjacent to or in relatively close proximity to major bodies of salt water. For practical purposes: the Atacama fringes the Pacific; the Sahara approaches the Mediterranean and borders the Atlantic and the Red Sea; the Arabian desert touches both the Indian Ocean and the Persian Gulf; the Kalihara is adjacent to the Atlantic; the Thar is near the Arabian Sea; the Great Australian Desert is not remote from the Pacific; and the desert to the east of the Caspian Sea could derive abundant waters from the Black Sea. An exception to this pattern is the Gobi Desert of interior China which is remote from major salt water sources and is hampered by massive and rugged mountain barriers to the south and west. Thus, at least portions of most of the major deserts of the world should soon wear that truly brilliant green so typical

when waters are first loosed upon suitable unleached soils of the desert.

Contributions to world agricultural production from these sources and expanded production in humid coastal areas through irrigation with ocean water would make possible the elimination of calorie-deficient diets. If this followed the usual pattern though the result would only be a greater world population which again would depress caloric intake in many areas—a vicious cycle. In this regards, quite possibly Josue de Castro, Executive Chairman of the United Nation's Food and Agriculture Organization, has the answer. Dr. Castro's analysis of world population versus the earth's food resources in his volume "The Geography of World Hunger" certainly deserves intensive study. Most applicable here is his well substantiated conviction that when protein content in the diet is sufficiently elevated for all, the rate of population increase will decline and a plateau be reached and maintained. His realistic and acceptable analysis is confirmed by numerous studies with breeding stock of various domestic animals. Is man so different that his response to increased protein consumption would greatly differ?

Within the next decade or so man will, through ocean water irrigation, be able to attain vastly greater amounts of protein for his own consumption. In doing so, protein quality and quantity needs to be stressed rather than the greatest possible mass of food. If this be done, before population increases can counteract the possible benefits to be derived, a leveling of world population total may well be attainable. Then, if man can learn to live with his own kind through rendering the "H" bomb impotent by decentralization, and if increased protein achieves an optium in man's numbers in relation to all available resources, the question may well be repeated—IS H_2O THE ANSWER TO THE "H" BOMB?

WHAT ARE THE IMPLICATIONS FOR AMERICAN EDUCATION OF THE SATELLITE PROPOSED IN IKE'S SPEECH OF JULY 29, 1955?

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DURING the summer of 1955 it was my pleasure to be the director of a Workshop in the Problems of American Public School Education at the Calvin Coolidge School of Education, Graduate Division, in Boston, Massachusetts. The workshop was designed to consider some of the basic problems facing Education in America today. Some of the problems considered were the very ones to be studied in the forthcoming White House National Conference on Education. During the class meetings the then-forthcoming Massachusetts State Conference, as well as the national one, was mentioned often.

The workshop met on Monday nights and as everyone knows it was on a Friday, July 29, that President Eisenhower announced to the world the plans for the proposed satellite. The following Monday, August 1, I proposed without warning that the workshop should work in their groups on the following question: What Are The Implications for American Education of the Satellite Proposed in Ike's Speech of July 29, 1955? I made a few brief remarks on some of the areas that I though would be affected: an already existent science teacher shortage, manpower to create and continue planetary research, etc., and then turned the students over to each other.

The make-up of this workshop was most unusual, though probably not more so than most groups where people meet to study

such problems. There were in the workshop the following: a musician, a cost auditor, a social worker, a Rabbi, a Judge of a District Court, a securities analyst, one elementary school teacher, four junior high school teachers, eight senior high school teachers, six shop teachers, and one aeronautics teacher, the last being a female jet pilot of some reknown. Four small groups were formed. They had been at work some thirty minutes when several problems came out into the open. The people admitted to gross ignorance of just what a satellite involved and of even of the distances and time involved not only concerning a satellite, but also space travel, light years, distance to the moon, etc. Then one group had arrived at a partial conclusion that some sort of 12 year science program should be evolved wherein good students would receive some science instruction each year of the elementary and high school career and the best would eventually be siphoned off into some sort of science work. There was present in the class a general feeling of bogging down. As Director, I made a few general remarks raising questions more than anything else and I asked them if they would like me to bring some people to the seminar who might be able to answer some of their more technical questions and supply some of the factual material they felt they were lacking. I asked them to continue their work as best they could and to have the group leaders make up their reports. This meeting was the third last of the session.

At the next meeting I brought in a personal friend who is a consultant engineer and who has done much work, study, and research in the field of aerodynamics and another friend who is a science teacher and who had recently completed his doctor's degree thesis on the science program and science teacher training in New England. I felt he could supply some information on the 12-year science program. These men were unknown to each other and followed each other without introduction because the engineer friend had to leave immediately. There were many questions put to each and it developed that the whole group had done considerable reading during the intervening week, one woman stating she had read every science magazine she could find on the newsstand, including the fiction ones. After the visitors had finished their talks, the groups continued their consideration of the main problem with the reports made out by the leaders of the groups being held by them for modifications, if any. It should be stated here perhaps that this workshop series was meeting in double sessions. At the end of this session reports were completed and sent to me.

The reports were mimeographed and given back to the seminar of the following and last Monday. The members of the seminar were asked to read them and decide on the items they considered the six most important of all they had before them. Unfortunatey one report was not available because the chairlady of one group had been and was seriously ill. That report is given below with the others and is indicated for identification. Since it was the last meeting and we had been working on this problem rather steadily and with a feeling of haste, I'm afraid, it was felt that each group—there were three new groups formed at random to consider the six most important implications from the three reports at hand—should make their report orally with the instructor doing the recording.

The first group to report suggested the following six items, not necessarily in order of importance:

1. Planned work should supplement the existent curriculum, such as could be developed in Teachers Colleges, or found in comic books, science fiction, TV;

2. Science courses will need complete overall and expansion;

3. Government agents should go to the schools and scout for future scientists;

4. Motivation of greater interest in Science should be achieved by pictures, field trips, etc., and teaching aids should be solicited from industry;

5. Space clubs should be stimulated as extracurricular and a program of prizes and scholarships should be initiated in the schools;

6. The teaching of ethical values of peace and the practical necessity for peace should not be neglected.

The above items have been edited little by me. They are perhaps more clear in their expanded form as they were reported in the original form by the groups. Those reports follow. After the six items were named above by the first group, the other two groups made their report modifying or supporting the above, but it was the consensus of the whole seminar that these six items were of primary importance. However, the second group requested that there be included:

1. Selection by aptitude tests: and
2. All information discovered in research should be shared.

The third group stated in addition that:

1. An adult education program in this area will have to be initiated;
2. The training of qualified statesmen is as important as training space shipmen.

The individual reports are more interesting and are presented below in their entirety. It was felt that the haste and the method of conclusion in the last meeting coupled with the length of time that the subject had been considered may have hastened the selection of the six important implications. At any rate they are not the ones as a group that the instructor would have chosen from the list, but this is after careful study by him.

Yet it must be recognized that the whole seminar was enthusiastic about the problem and did work diligently. The reports are presented below as submitted, mimeographed, and discussed.

GROUP B REPORT

Consensus of Opinion

The announcement of the proposed satellite indicates that the conquest of outer space may become reality in the near future. America must be ready to meet the challenge of the "outer space age." Gradual evolution of our curriculum will not suffice. Swift and bold changes are needed in the following areas:

1. Knowledge of outer space by
   (a) Preparation of teachers for teaching Astronomy.
   (b) Teaching Astronomy from the first grade on and increasing the knowledge of this subject from year to year.
   (c) Equipping the schools with planetria, telescopes, etc.
   (d) Motivating the interest of students in outer space by formation of space-clubs, in which children on a volunteer basis deepen their knowledge of space problems, build model space ships, etc.
   (e) Adding a one-year course in Astronomy to the High School curriculum.
2. Expansion of Science program by
   (a) Starting the teaching of Mathematics and Science at an earlier age.
   (b) Making the study of those subjects more appealing to students.
   (c) Selecting by aptitude tests those qualified for an intensive Science program.
   (d) Establishing scientifically oriented elementary classes in Science for those having aptitude for it.
   (e) Motivating greater interest in Science by pictures, movies, field trips, visit to Science Museum, etc.
   (f) Encouraging Scientific thinking. (A member of the group pointed out that Life Magazine in a recent issue described the method of a professor at M.I.T. in encouraging creative scientific thinking).
   (g) Encouraging students to continue their scientific studies by awarding prizes and scholarships.
   (h) Attracting scientists to teaching by raising salaries to a level equal to or better than the salaries offered in industry.
   (i) Arranging in-service programs.
   (j) Soliciting the assistance of industry. Industry should continue and enlarge the program employing college graduates as trainees, and enable others to complete their scientific schooling while working in industry.
   (k) Government subsidies.
3. Public relations
   (a) The public must be made aware of the urgent necessity to make these changes in the schools.
   (b) Parents should be informed as to the new opportunities presented to their children.
4. Establishment of enduring peace by
   (a) Teaching the ethical values of peace.
   (b) Teaching the practical necessity of peace, since the domination of outer space by

any one nation would enable it to rule the whole world.

(c) Promoting a program trying to establish peace and understanding between the two worlds following the suggestions made in the group discussions of July 18. (This refers to another problem discussed concerning the achievement of peace and understanding between the two worlds.)

In conclusions, the question was raised, how such a new orientation in education would affect the schools. It was felt that the regular school program will be continued for those desiring and better suited for the traditional curriculum. However, there will probably be a shift in emphasis to Mathematics and Science. The need may also arise for special scientific schools.

GROUP C REPORT

I. *Curriculum*
  1. Extensive overhaul and expansion in its entirety
    (a) Scientific introduction and general survey of special mechanics required.
    (b) Experimental text books covering pertinent subject matter now being prepared for grades 3 through 7, both inclusive.
    (c) As to elementary pupils and some laymen, pioneering accomplished through media of TV, comic books, and science fiction.
    (d) Courses in adult education required.

II. *Selectivity*
  1. Scientific and vocational training
    (a) Indoctrination of elementary grade pupils.
    (b) Special testing techniques for purposes of selectivity of very young for conditioned training.
    (c) Vocational guidance program will require improvement and expansion:
      (1) For more accurate determination of individual capabilities and capacities;
      (2) For a more specific basis of selectivity rather than mere encouragement without regard to inherent preferences or capacities;
      (3) Platonian theory of selectivity useful as a guide, but government control of individual must be avoided;
      (4) Speeds, strains, and stresses of new age may result in mental deterioration so that a super race may be developed according to mental fitness.

III. *Moral Aspect*
  1. Changing values and mores will affect society as a whole
    (a) Religious influences may diminish.
    (b) Home and family life will be altered.
    (c) Conventional marriage formalities may be disregarded.
    (d) Biological functions may be vitally affected.

IV. *Basic Research*
  1. Einstein's theories as to monetary benefits of being a plumber of great impact
    (a) A creative thinker can acutely analyze date of his environment.
    (b) Top-rank creative thinkers avoid regulations.
    (c) Spotlight fame not enough;
      (1) Need for cash on par with major business executive; and
      (2) Freedom for private research;
    (d) Government spends billions for enengineering; too little for creativity.

V. *Government*
  1. Training of qualified statesmen as important as training space shipmen.
  2. Plenary sessions
  3. Interplanet U.N.
  4. Question as to concentration on purely defensive matters, or take the offensive
  5. World relations
    (a) One world
    (b) One government
  6. Checks and balances outdated
  7. New industrial and economic revolution resulting in a new supercivilization

GROUP D REPORT

1. This group feels that young students have already been conditioned to accept space travel and the certainty of reaching certain planets because of space fiction and popular science they have read and TV and movie shows they have seen. Instead of adults scoffing at the fiction idea of space travel, we should encourage the children to think that the possibility of space travel can be an actuality.

2. New tests must be devised to meet the challenge of this new inter-planetary era.

3. Science curriculum needs a complete overhauling.

4. Give specialized training to those who show special aptitudes.

5. Subsidize education.

6. In this day of the shortage of scientists we think the government should have agents scouting the lower grade schools (similar to baseball scouts) for possible candidates to train and subsidize the education of those children.

7. It must be realized that if information secured by the satellite (expedition) is given freely to all the world, it will provide ammunition for rival nations to speed up plans and methods for

building a base in space from which strategic point the whole world could be annihilated.

8. A common language, probably Esperanto.

9. All information secured should be used to make progress in attaining our goal of one world and the true brotherhood of man for the purpose of outlawing war.

10. Use offers of industry, as General Electric, Westinghouse for teaching students the science as used in their industries. Have one representative from each industry visit schools to teach their speciality.

11. A well organized science program as recommended by the visiting science teacher.

12. This program should be comprehensive with all branches included.

13. Administrators should be made aware of the need of well-trained science teachers.

14. Inducements should be held out to students to enter the field of science teaching.

15. We need 10,000 science teachers. We are getting 3,200 potential science teachers.

16. Fall River offers more courses in science than any other school system in New England.

GROUP A REPORT

This report was arrived at in a group at the same time as the others but it was not available for final study with the others because of the illness of the leader-recorder.

HISTORY

As far back as scientists of ancient Egypt, Greece and Rome, we have records that many of them were dreaming of flying to the moon and reporting the observation of "flying saucers."

Scientists of the Middle Ages envisioned airships which would ovecome gravity and so push through outer regions of the universe.

Leonardo DaVinci, one of the greatest minds of the Italian Renaissance period, laid down the principle of aviation and foretold the reality of space travel.

In the 19th century Jules Verne wrote imaginative tales about people traveling into space. In those days these stories were sheer fantasy, today, however, the twentieth century scientists talk of trips to the moon.

We remember that a little over fifty years ago the Wright brothers were scoffed at for trying to conquer the air with their flying machine. In 1903 they used their knowledge of science together with their creative ability and built a crude flying machine. Today jet planes travel faster than sound.

American scientists are probing deeper and deeper into the secrets of our earth's atmosphere, seeking physical and chemical phenomena of our universe. Astronautical engineers, astrophysicists, and astromedical men, specialists in their fields, are doing research and experimentation that one can say with assurance that flight into space is possible and will eventually meet with ultimate success.

Most of the problems confronting the space traveler are already known; speed, space ships, survival of human beings in space, not forgetting the safe return to earth of crew and ships.

Today it is the belief that a trip to the moon will not be made in one continuous flight. A man-made satellite, a space station will be constantly circling the earth, it will be the first stop before one takes off, in a true space ship, for the moon.

In this age of science we cannot talk about lack of new frontiers as the answers will be beyond our constricted globe into outer space.

The group believes that travel into outer space is very near reality and that people walking on this earth right now will make the first trip. A change in our school curriculum to prepare for this era is essential —some kind of a progressive core-curriculum.

But before we can make any changes in our curriculum we shall have to do a very good public relations job. First we will start with the teachers. We shall need aviation workshops for all teachers who are working today in this air-age.

When we have the teachers well indoctrinated with the importance of this air-age and with the countless possibilities this new era opens up to our students then the general public must be educated.

There are many organizations actively engaged in the field of Aviation Education.

Teachers should make an effort to become acquainted with the programs of these various organizations. We hate to admit it, but as Mrs. ———— has pointed out, New England is far far behind in the field of Aviation Education. We in New England have a great deal of work to do to catch up with the rest of the country and not let the "Hub of the Universe" become a misnomer.

Our proposed Air-age Program workshop for all teachers.

I. Orientation
  1. Objectives of Aviation Education—General
  2. Objectives of Aviation Education Workshop—Specific
  3. Film #1 Shell Series "History of Aviation"

II. How a Plane Flies
  1. Kinds of planes
  2. How a plane stays in the air
  3. How a plane is controlled in the air, in take-off and landing
  4. Film #2 Shell Series "Lift and Drag"
  5. Glider model building demonstrated
  6. Film #3 Shell Series "Thrust and Forces"
  7. Film #4 Shell Series "Stability and Control"
  8. Aircraft powerplants

III. How the Weather Affects Flying
  1. Weather hazards—why a pilot needs to study the weather
  2. Fundamentals of forecasting
  3. How weather maps are made

IV. How an Airplane Gets from Place to Place
  1. Flight operation and flight planning
  2. Navigation
  3. Communications
    a. Radio in aircraft
    b. Control towers
    c. Airway traffic control
  4. Instrument flying and landing
    a. Ground Control approach CCA
    b. Instrument landing

V. Field Trip to Logan International Airport
  1. Airport operations
  2. Airline operations
  3. Vocational familiarization

VI. How the Airplane Affects Society
  1. Industry
    a. Manufacturers of aircraft and components
    b. Air carrier operations
    c. Air freight
  2. World trade and marketing
  3. International relations
  4. Changes in world geography and its effect on society
  5. National security—definition of air power and air supremacy
  6. Comparison of air power U.S. and U.S.S.R.
  7. Civilian defense
    a. Radar screens
    b. Ground observer corps
    c. Interceptor problems

VII. Teaching Methods of Aviation Education
  1. Organization of instructional units to provide integration of aviation materials into existing outlines
  2. Techniques being used successfully by primary school teachers

VIII. Continuation of Teachers
  1. Material available for teacher use
  2. Bibliography of materials
  3. Film and film strip bibliography
  4. Summary of workshop

We must remember that air-age education can be integrated with each grade and each subject.

TV and the Comic Books have indoctrinated the present school children with the importance of space travel, etc. Very little motivation is actually needed there. Our problem lies with the adults and the first groups of adults that need motivation and education are the present-day educators. Thanks to Dr. ————, we shall be among the first New England teachers to be made aware of the need for this type of education, and we hope we shall be able to make some kind of a worthy contribution along this line.

There is no doubt as to the value of group study of such an important question as was analysed here. Undoubtedly many other such groups will make studies of this very question. It was fortunate that this workshop was fluid in the type of question that could be analysed; it was unfortunate that more time for organization was not available. However, perhaps this time factor made for a more spontaneous report and some real creative thinking. Some of the items above are fascinating in themselves and their implications. It is not the intention here to comment on the findings of the individual groups but merely to present them for study and analysis by those interested, and particularly for comparison with findings of similar groups which may have considered this question while it was "hot off the press." One of

the most interesting things observed by the director as he went around the groups while they were working and as he read over their conclusions was the similarity of thinking in so many of the areas. It is hoped that other educators may find in them material for serious consideration in planning curriculum revision. It is hoped that the satellite in the curriculum may not be included a hundred years from now, but this year! It is the writer's feeling that one group of teachers will always include it!

Yet the challenge of the question discussed in the report is not primarily made to educators at large. It is made specifically to those teachers and personnel whose immediate concern is the teaching of science to America's youth. It is these teachers who must lead the pack. Never will the science teacher find more readiness for co-operation from his colleagues. He must seize this moment to publicize and inform the school public and the public at large. The time is now. When the satellite is circling the earth, the science teacher may find it is too late. We, of the American public never want to be too late!

THE READING PROBLEM IN COLLEGE SCIENCE INSTRUCTION

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FLESCH READABILITY SCORES OF TWENTY WELL-KNOWN TEXTBOOKS

DURING more than two decades of science teaching, the senior writer has observed that he has spent much more time and effort in correcting errors in the "tool subjects" than in the actual teaching of the subject matter and understandings of science. Our college students are poor writers; freshmen are notoriously bad spellers; and students who cannot read well or understand the printed word are obviously at a disadvantage in college science courses. Teachers and investigators have therefore long felt that many college students fail because they are not able to read well.

The Problem

We have made a longtime study of the role of reading in science instruction and have made observations and carried out some experiments on this matter. These we hope to publish later. The present contribution is the result of the study of the "reading ease" of twenty "popular" textbooks used in college science courses; the study is an effort to determine whether some of the failures in our courses in science may have been caused by the books we use.

Method

We selected as a measuring instrument the Flesch "Method of Readability." This is described by Rudolph Flesch in a number of publications, including "How to Test Readability" (1951), which we used as a handbook and guide.

Flesch suggests seven styles or categories of "reading ease" and classifies them as shown in Table I .

TABLE I

FLESCH READING EASE SCALE (MODIFIED)

Sentence Length	Syllables per 100 Words	Reading Ease Score	Style or Description
29 words	192	0– 30	Very Difficult
25	167	30– 50	Difficult
21	155	50– 60	Fairly Difficult
17	147	60– 70	Standard
14	139	70– 80	Fairly Easy
11	131	80– 90	Easy
8	123	90–100	Very Easy

Flesch's books [1] and techniques have been the subject of much discussion; but it seems that no writer or investigator has condemned his method. We felt justified therefore in using his procedure to find the Reading Ease Scores of twenty selected textbooks. These books were in Biology, Botany, Chemistry, Natural Science, Physical Sciences, General Education Biology, and Physics.

Results

The Reading Ease scores are summarized in Table II below. Flesch also has a Human Interest Scale, in which any score below 10 places the book in the category "Dull." The results of Human Interest Scores were so uniformly low that neither graph nor table need be reported in this communication. Four books (numbers 12, 10, 16 and 4) rated only 8; book number 3 rated 7; book 20 rated 2; and book 19 rated 0.007. All the other textbooks scored zero on the Flesch Human Interest Scale. According to this scheme therefore, all of these 20 science textbooks are DULL.

TABLE II

FLESCH READING EASE SCORES OF TWENTY COLLEGE SCIENCE TEXTBOOKS

Book No.[2]	Average Sentence Length	Syllables per 100 Words	Reading Ease Score	Comment or Style
1	21.00	158	54	Fairly Difficult
2	19.08	163	50	Fairly Difficult
3	21.73	160	49	Difficult
4	20.49	162	49	Difficult
5	23.36	159	49	Difficult
6	17.60	168	47	Difficult
7	18.97	167	46	Difficult
8	19.68	167	46	Difficult
9	20.49	166	46	Difficult
10	17.97	170	45	Difficult
11	17.87	171	44	Difficult
12	20.00	171	42	Difficult
13	21.36	169	42	Difficult
14	16.07	177	41	Difficult
15	20.49	172	41	Difficult
16	19.68	159	39	Difficult
17	21.36	173	39	Difficult
18	22.90	172	39	Difficult
19	21.73	173	38	Difficult
20	24.12	173	36	Difficult

Discussion

The results reported in the Tables above hardly need comment. Eighteen of our most "popular" science textbooks are (by the Flesch Scale) *difficult* to read; only two are *fairly difficult*. None is *standard;* none is *fairly easy*. It is important to point out also that on the Flesch Scale, of the seven categories from *Very Easy to Very Difficult,* the style called *Difficult* has above it only one category, *Very difficult*. The inferences from these observations should be obvious, especially since, as noted above, all the books are *Dull* to the average reader.

A college student meets many problems at the beginning of his career. Besides having social, financial, moral, personal and psychological barriers to hurdle, he suddenly realizes that he has learning problems too. He finds that he cannot get through his college work as he did through the grades or high school. Sometimes, the student discovers for the first time that he *must* study; and often, he has not yet learned how to study.

If the college freshman enters a science course, he meets other and more severe challenges as well. Much of his information he must get for himself from books, manuals, periodicals, and encyclopedias; he has to take notes from lectures, from reading sources and from discussions; and he must be able to present what he has learned in good English. Besides all these, he meets new ideas daily—some contrary to views he has had all his life. He also meets dozens and even hundreds of new words, some of which he has never seen, or heard, or used before. Some which he has

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[1] Since this study was made Flesch's latest contribution, "Why Johnny Cannot Read" (1955), has been reprinted in newspapers or reviewed in many other periodicals and has provoked a veritable flood of comment.

[2] The books listed in this table are not in the same order as the list found in the bibliography. These are in order of difficulty; the other list is alphabetical.

met before puzzle him, because in his science classes they are now used with new and strange meanings almost beyond his comprehension.

The difficulties of the science vocabulary have been noted by many workers, including Thorndike, Powers ('26), Pressey ('31), Curtis ('38) and many others. Science textbooks, long known for their compactness, have repeatedly been called "consistently heavy." In fact, some science writers take pride in the fact that their sentences and paragraphs are so well-knit that omission of even a single word or phrase reduces the effectiveness or changes the meaning. "Often a single sentence is so burdened with facts that a student grasps only a few of the ideas or acquires only a confused notion . . . ." (Leary and Gray, 1940). Thus, the college student, already a notoriously poor reader, meets scientific facts and ideas, presented in long, complex sentences, made up of difficult and unfamiliar new words of many syllables. He must also wrestle with these new words and ideas in a strange terminology—the "accepted scientific jargon" of McAllister (1955).

Book 2 (in Table II) published in 1949 has a score of 50 per cent: Fairly difficult; its revised edition (1954) has a score of 47 per cent: Difficult. A similar change for the worse is seen in book 1 (Table II)—probably the most popular college textbook of science published during the last two decades. Rated at Fairly difficult in the 1950 edition, it turns out to be difficult in the latest rewriting (1953). These facts not only justify Gray's view (1940) that most science books are "heavy stuff" but ought also to cause us some alarm: our writers are now adding so much "recent material" that our textbooks are getting longer, harder to read, and heavier (in both senses).

As shown in the list below, 17 of the books investigated were in the field of Biology, 8 were in General Biology, 4 in Animal Biology or Zoölogy, 2 in Botany, 2 in Human Anatomy and Physiology, and 1 in Bacteriology. There was 1 book in each of the fields of Chemistry, Physics, and Physical Science. Analysis of the reading ease (or better, reading difficulty) in these several fields revealed no real differences. On the Flesch Scale, scores from 30 to 50 mean difficult, and from 50 to 60 mean fairly difficult. The only two books with scores of 50 or above were in General Biology. Among the others (scores 30–50: difficult) when arranged in numerical sequence, Chemistry was about halfway down the list and Physics and Physical Science were near to the bottom.

Conclusions

We need hardly point out that superior students in the upper college classes, science "majors," science teachers and subject matter specialists would probably rate all of the 20 books studied from good to excellent. The books are full of up-to-date information, have excellent and sometimes significant and clever illustrations and supply a wealth of facts, ideas, and attitudes. Teachers feel good science textbooks should include these. That, of course, is the reason for their widespread use and explains why most of these books have been repeatedly reprinted and revised.

But these ratings are the views of persons who have already studied college science, and who therefore know the facts and are familiar with the ideas and the vocabulary of the subjects. On the other hand, to college students, say of the first two years, to whom the facts, ideas and terminology of science are new, these teacher-popular books may be student-terrors.

The following comments and suggestions seem therefore to be appropriate:

1. College teachers should be willing and ready to help their students with the reading matter assigned in science courses.
2. Authors of college science textbooks should not become so engrossed with the presentation of subject matter that they forget the students who are to read their books.
3. Compact, long sentences, with words of many syllables offer a serious reading handicap to the student beginning studies in college sciences.

4. The conventional, impersonal writing used in scientific articles and research reports should not be used in college textbooks. The red-tape language of officialdom and the jargon of legal documents may be understood by specialists familiar with that type of writing and with the vocabulary, but have no place in college textbooks.

5. The "padded writing" of researchers and technical writers (Struck 1954) should never be used in books of instruction, even if it is accepted in professional journals and technical reports.[3]

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THE HISTORY AND PHILOSOPHY OF SCIENCE: A CHALLENGE TO HIGHER EDUCATION

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GENERAL Education, and Science as a part of general education have attained an important place in American Higher Education. Books, periodical literature, and symposia explaining the function of both attest to this fact.

There exists a feeling, at least in the mind of the writer, that the energies of most scientists and educators are so consumed in specialized reading, teaching or individual research, until the mention of new courses such as the History of Science, or the Philosophy of Science, represents the "Idle Pranks of a Dreamer."

This short and incomplete work hopes to dispel this view, the purpose of which may be examined from the following viewpoints:

1. To show the need for both history and philosophy of science—a unifying discipline in higher education.

2. To evaluate the instructional problems faced in incorporating these disciplines within present curricula offerings.

3. To show the present condition of neglect now facing these subjects in many of our institutions.

Those who insist that present schedules are overloaded, and who desire repetitious debate, will argue that the history and the philosophy of science as distinct subjects are unnecessary. The contention is that such material as would constitute these courses is contained within the framework of the regular science courses or in an introduction to philosophy. Consequently, their omission offers no challenge for inclusion in a program of higher education.

Such an argument may be tenable if the consequences from which it were derived were accurate propositions. A view of this sort more than anything else represents a myoptic conception of both the history and the philosophy of science from the point of content and objectives.

The present obscurity of these courses becomes a bit puzzling when we realize that an understanding of science, its nature, growth and evolution, has been predicated upon its past history and a prevailing climate of ideas, many of which were traditional and philosophical in nature. Evidences of the historical and the philosophical trends in the formulation of new ideas can be seen in the following instances.

The colonial fight for freedom in the new world is best glimpsed from a study of its patriots as Patrick Henry, Jefferson, Washington and Ben Franklin. It is also true that the political and religious climate, and the human activities of Thales, Ptolemy, Aristotle, Galen, Harvey, Newton have the same meaning to an understanding of the growth and development of science as the science patriots.

Sarton,[1] a pioneer in the history of science movement, and many of his able students, have called attention to the lack of status which the history of science has at the college level.

Cohen [2] has shown particularly, the need for a wider diffusion of the history of science in general education. Hauser [3] feels there is likewise an urgent need for the history of science in the education of the prospective scientist.

Frank,[4] Bestaloffy,[5] and others have pointed out a similar need for the philosophy of science which would offer the student evidence of the need for clear and logical thinking which is paramount in the evolution of science. At this point the question may be well asked, what significant contribution do these subjects have to contribute to the intellectual development of students now burdened with many courses from which they must extract the meat of knowledge?

Any academic answer may not suffice. Nash [6] has suggested a function for the history of science in general education, which in part answers the question raised above. He believes that students should be made aware of the historical difficulties, delays, and the failures of science as well as its triumphs. Likewise, Stimson's [7] findings indicate functional objectives for the history of science in general education.

A study of 445 students for a period of 25 years in the course entitled *History of the Scientific Point of View* gives valid grounds for offering such courses as parts of both general and professional education.

A listing of the functional objectives for the inclusion of science in general education polled by students studied in Stimson's study relative to higher and lower frequency are listed for inspection:

1. Increased the awareness of the history of ideas.
2. Developed historical perspective.
3. Developed an appreciation of the scientific method in other fields than just the laboratory, and integration and correlation of the fields of knowledge beyond the somewhat artificial barriers of college departments.

Most of all, the fact that science is a continuing factor impressed the students. Values exhibiting a lower frequency are worthy of mention.

1. Opened possibility for later reading and study.
2. Widened range of reading done.
3. Related various fields of the curriculum to each other.
4. Synthesized science courses.
5. Increased understanding of laboratory procedures.
6. Led to the selection of more science or mathematics courses.

It is true that here and there colleges offer courses in the history of biology, chemistry, mathematics, and so on, which usually are required for departmental majors. These courses generally have the shortcoming of being written by the subject matter specialist for the specialist-to-be and reading interest outside of the field is low.

It is quite obvious that a student interested in mathematics would find a historical account of Edwin Smith's "Rhind Papyrus" of more interest than a student interested in biology; however, both should find Sarton's monumental history of science—*Ancient Science Through the Golden Age of Greece*—of equal interest.

The history and the philosophy of science certainly would not be concerned with an isolated gathering of facts by students; emphasis would be placed on those facts as vehicles through which science has contributed to the stream of history.

The instructional difficulties faced by colleges desiring to institute such courses are not always easily overcome. Crews [8] more than three decades ago, clearly categorized them in this manner:

1. The character of the course.
2. The place of such a course in the curriculum.
3. The man for the course.

The nature of the content to be used and the approach, be that biographical or case history, would demand clear study and comprehension from the instructional viewpoint. The training needed for the job of offering either history or philosophy of science presents a delicate problem. Shall he be scientist, philosopher, historian, or one with good acquaintanceship in the broadened areas of knowledge?

The points of view for and against any of the four are interesting. The limited training of the general historian in the sciences would hardly permit him to be a capable judge of scientific history; but a historian well grounded in the fundamentals of science would free such a course from technical details which could be acquired by the students, and would add a breadth of view enriched by the historical perspective and flavored with gems of literature, bits of philosophy and religion. The correlation of science with the history of civilization would be better seen, for the reflective consideration of man, would aptly be portrayed more vividly by historian than scientist.

The technical scientist by nature of training could not remain long in the stream of history due to preparation, hence the nature of the historical process would be lost. The philosopher who is not tied dogmatically to a system of philosophy or school of thought, and who has a good foundation in the sciences can do much to direct such courses, and especially the philosophy of science.

Carre,[9] a historian, has suggested that the prospective historian of science should have at least the competence that might be obtained by two years of graduate work at one of the better universities by the special student of science.

Sigerist [10] feels that aside from an understanding of science there must be training in methods of historical research which would permit background for evaluating and interpreting historical sources. Added to this must be a thorough knowledge of Greek and Latin which would be a minimal requirement; Arabic, along with several other languages would be useful preparation.

Broadly, we have brought to focus an aspect of the problem, adequate training of the historian of science. Data was gathered

by a questionnaire circulated a year ago. These data may be revealing as to what the colleges and universities are doing with these disciplines as curricula offerings.

The questionnaire used was a simple one-page device sent to the Dean of Instruction.

The questionnaire was sent to 135 colleges and universities which included 31 Negro colleges who participated in the United Negro College Fund. These colleges extended training to a student population of 23,000.

Thirty of these 31 institutions sampled are located in the 11 Southern States from which 73 per cent of the Negroes of college age live.

The remaining schools included in the study represented a good geographical distribution. No criteria was set as to enrollment, means of support, or religious affiliations.

In spite of the delay in reporting the results, I feel that the data are still generally valid and hence should be reported.

Of the 107 colleges and universities who answered the questionnaire, 58 of them representing 54.1 per cent answered that they did not include in their curriculum, in any form whatever, a course directly or indirectly connected with the teaching of the History of Science. Ten of the above schools included the course in both the Departments of History and of Philosophy. In all except four of the institutions, the course was on the undergraduate level, and in every instance except two, the subject was listed as an elective.

Slightly more than half of the schools included the History of Science under the offerings of the Department of Philosophy, while the remainder listed the course under the Department of History. It was interesting to note that most of the schools indicated that it was taught by a joint faculty composed of science and history professors. About 20 of the colleges reported that they found it necessary to exclude the History of Science from their catalogue offerings because of the lack of an available textbook and suitably trained faculty members to handle the course.

Sigerist has made some far-reaching suggestions for improving the history of science instruction. Science instruction does not begin at the college level as we might think that it would; such instruction should start in the primary grades—at this stage a simple biographical approach could be used. At the secondray level, he feels that the history of science should become part of the teaching of history as well as science. Breasted's *Ancient Times, A History of the Early World* could be used as a suitable text. Provided a special course in the history of science was considered for the high school, Dampier's, *A Short History of Science* would be ideal. The ideas are timely and could well serve as the basis for a core program which in time would develop a better knowledge of science through an understanding of its history.

The professions are cognizant of the need for their members to be well grounded in the history of their profession. De'-Angelo[11] has urged busy physicians to consider the study of medical history as a hobby which will stimulate their hidden talents and give them a better understanding of the ills they are treating.

Our colleges, private and public alike, must concern themselves with providing curriculum provisions, scarcely existent now, for study in both the history and the philosophy of science.

There is an urgent need at the college level for students to get a breadth of view, to develop patterns of logical thinking and to see association of ideas. This kind of education is as much needed as a factual understanding of equations and formulae.

Both the History and the Philosophy of Science will do much to meet this vacuum for breadth of knowledge now existing at the college level for the scientist and the non-scientist alike.

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A STUDY OF GENERAL SCIENCE LEARNING OF EIGHTY-TWO SELECTED STUDENTS IN NEGRO HIGH SCHOOLS OF LOUISIANA

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THIS report is based on a testing program in general science conducted by the science department of Southern University during the second semester of the school year 1952. The general science testing is only a part of the science competitive testing program of the Louisiana Interscholastic Athletic Literary Association. Other science testing in the program includes competitive testing in algebra, geometry, general mathematics, biology, and chemistry.

PURPOSE

The major purposes were (1) to ascertain the effectiveness of the teaching of general science in the thirty-one schools which participated in the testing program, and (2) to serve as a means of improving the physical science instructional program at Southern University.

TECHNIQUE EMPLOYED

A set of study questions was made out by the author and mailed to the participating schools during the first part of the first semester of the school year 1951. Important concepts and principles for the study questions were taken from the following areas:

Astronomy	Physics
The Universe	Machines
Meteorology	Magnetism and Electricity
Air	Light
Weather	Sound
Chemistry	

Questions in geology were not included in the areas mentioned above because most of the high school textbooks examined which were used by teachers and students did not include a teaching unit in geology.

A teacher-made mastery objective test was administered in general science to the best students selected by the science teachers of the participating schools.

Orleans and Symonds[1] concluded in their study that teacher-made objective tests may be as valid and reliable as standardized tests. However, the principal function of

[1] Orleans, J. B., and Symonds, P. M. "The Comparative Reliabilities of Standardized and Teacher-Made Achievement Tests When Given in the Middle of the Year," *Journal of Educational Research*, 25:127–28, 1932.

any mastery test should be for instructional purposes.

The teacher-made mastery objective test was designed for a two-fold purpose: (1) to improve high school science teaching, particularly in general science, and (2) to serve as a means of helping the science teacher certified in fields other than science to improve his instructional program. The questions for the teacher-made mastery objective test, 70 in number, were made up from the areas listed above.

PARTICIPATION IN THE TESTING PROGRAM

Table I shows that eighty-two selected students from twenty-nine public schools, two parochial schools, participated in the general science competitive testing program in the state.

TABLE I

PARTICIPATION DISTRIBUTION IN THE GENERAL SCIENCE COMPETITIVE TEST

Schools	Number	Students	Number
Public	29	Girls	49
Parochial	2	Boys	33
Total	31	Total	82

RESULTS OF TESTING

The geographical location of the schools participating gave a good representation of the status of learning in general science in the state. The results of this test in terms of scores is given in Table II.

Table II presents data for comparing the performance of boys and girls. The scores in the first percentile for the girls is significantly higher than those for boys as shown in Table III. This shows that the girls had gained more information from the areas of knowledge listed above on the teacher-made mastery objective test.

TABLE II

RANGE OF SCORES ON GENERAL SCIENCE COMPETITIVE TEST

Students	Score Range
Girls	39.5–86
Boys	38.0–90

Table IV shows that the eighty-two selected students were weak in chemistry and physics:

TABLE IV

PERCENTAGE OF QUESTIONS ANSWERED CORRECTLY

Areas	Number of Questions Presented	Number of Students Answering Questions Correctly by Areas	Per Cent
Astronomy			
The Universe	12	63	76.82
Meteorology			
Air	10	46	56.09
Weather	10	58	70.73
Chemistry	10	23	28.05
Physics			
Machines	8	5	6.09
Magnetism and Electricity	8	7	8.54
Light	6	10	12.19
Sound	6	4	4.88

Total Number of Questions 70
Total Number of Students 82

ANALYSIS OF DATA

This classification of data shows that while the scores of the girls range from 39.5 to 86 and those the boys range from 38 to 90, the upper fourth of the girls performed slightly better on the teacher-made objective test than the upper fourth of the boys, as can be seen from Table III by comparing the first percentile for the boys and the first percentile for the girls respectively.

Table III also shows the average score

TABLE III

PERCENTILE AND MEANS

Students	First Percentile	Second Percentile	Third Percentile	Means
Girls	74.5	60	49	60.32
Boys	68.0	61	50	59.85
Total group	....	..	..	60.13

for the girls to be 60.32, while that of the boys is 59.84, a difference which is probably insignificant. The average score for boys and girls is 60.13, which indicates that the deviations from the mean are negligible.

From Table IV, it seems that very little emphasis was placed on chemistry and physics when compared with astronomy and meteorology. This deficiency in chemistry and physics may be due to the fact that only three high schools offer a course in physics and fourteen high schools in the state offer a course in chemistry as cited by Dr. Warren J. Lee [2] in his study.

CONCLUSION AND RECOMMENDATIONS

While the average score is not depressingly low, it is hoped that by continuing this testing program in general science, high school students will be stimulated to a greater degree in the desire to master the subject matter content, learn to associate, and make use of the facts in everyday living.

In view of the facts revealed in this study, the following recommendations are offered:

1. That more high schools in the state offer good courses in physics and chemistry.
2. That the present general science course be improved with an addition of more thoroughly taught subject matter content, with emphasis on the functional areas of social living and scientific specialization in areas dealing with the nature of the physical universe and changes through time.
3. That a unit in geology be taught to high school students.
4. That high school science teachers take advantage of an in-service educational program directed to their individual needs as a means of improving their instructional program.
5. That high school science teachers make use of all the available resources, local, state, and federal to the fullest possible extent in their in-service education.
6. That the competitive general science testing program be continued.

[2] Lee, J. Warren. "Status of the Natural Science Teacher In Negro High Schools In Louisiana," *Science Education*, 37:36–40, 1950.

A STUDY OF THE PERFORMANCE OF ONE-HUNDRED AND FORTY-FIVE SELECTED COLLEGE FRESHMEN ON THE NATIONAL ACHIEVEMENT STANDARDIZED GENERAL SCIENCE TEST

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THE PROBLEM

The purposes of this study were (1) to ascertain the extent to which entering college freshmen for the Summer Session of 1953, Southern University, have mastered subject-matter content in general science, and (2) to make use of the data as a means of improving a physical science course, taught by the writer, in order to meet the present needs of the students.

METHOD AND PROCEDURE

The National Achievement Standardized General Science Test was administered to 60 male and 85 female students. The General Science Test was designed for grades 7–9 inclusive. This test was selected because it measures the student's knowledge of scientific concepts; his ability to identify objects from illustrations and to recognize important men of science; his ability to define scientific terms; his knowledge of uses of objects; and his mastery of scientific facts. The students had as much time as wanted to complete the test. All tests were given and scored by the writer.

HIGH SCHOOL

The one-hundred and forty-five selected college freshmen were from fifty-one pub-

lic high schools, two parochial high schools in the state of Louisiana, and two public high schools in the state of Mississippi. Of the sixty male students, six were graduated valedictorians, two were graduated salutatorians, and three as honor students of their respective high schools classes. Nine of the female students were graduated valedictorians, two were graduated salutatorians, and three as honor students.

HIGH SCHOOL SCIENCE BACKGROUND

Table I shows that the majority of the students, both male and female, have had all of the science courses listed save chemistry and physics.

TABLE I

HIGH SCHOOL SCIENCE COURSES TAKEN BY PARTICIPATING STUDENTS

Subjects	Males Number	Males Per Cent	Females Number	Females Per Cent
General Science	52	86.66	69	81.17
Biology	55	91.66	77	90.58
Algebra	54	90.00	77	90.58
Chemistry	31	51.66	56	65.88
Physics	4	6.66	4	4.71
Geometry	51	85.00	70	82.35
General Mathematics	55	91.66	75	88.24

RESULTS

Table II shows that the scores on the General Science Test for the entire group, both male and female students, range from 14–96. The highest score on the test is 120. The National median, 73—chosen by the writer—is for students in the ninth month of the ninth grade. It will be noted from Table II that the group mean—males and females—is much below the National norm. The mean of the total group is also below the National norm. The majority of the students, males and females, earned scores below the National norm on the standardized test.

The National norm for high school students in the seventh month to the ninth month of the seventh grade is 46–49 inclusive. When one compares the medians of the males and females plus the entire group with the National median, it is apparent that the students are at the seventh grade level in mastery of subject-matter content in general science.

With the exception of the female students on Part I (General Concepts), Table III shows that the majority of the students, males and females, answered correctly less than 50 per cent of the total number of questions asked in each Part of the test as listed.

TABLE II

FREQUENCY DISTRIBUTION OF THE SCORES[1] AND THE COMPARISON OF NORMS BY SEX

Males Score Range	Males Frequency	Males Per Cent	Females Score Range	Females Frequency	Females Per Cent	Means National[2]	Means Males[3]	Means Females[3]	Means Total Group[4]
86–96	3	5.00	80–90	1	1.18	73	49.01	46.93	47.79
75–85	3	5.00	69–79	3	3.53				
64–74	2	3.33	58–68	13	15.29				
53–63	12	20.00	47–57	30	35.29				
42–52	18	30.00	36–46	21	24.71				
31–41	17	28.33	25–35	14	16.47				
20–30	5	8.33	14–24	3	3.53				
Total	60	99.99	Total	85	100.00				

[1] Highest possible score is 120 points.
[2] 73 is the National average score for pupils in the ninth month of the ninth grade.
[3] Based on the total frequency of the grades by the group.
[4] Mean of both males and females based on the scores of the total group.

TABLE III

NUMBER AND PER CENT OF CORRECTLY ANSWERED QUESTIONS BY PARTS ON THE GENERAL SCIENCE TEST

Parts	Males Total No. of Questions	Males No. of Questions Correctly Ans.	Males Per Cent	Females Total No. of Questions	Females No. of Questions Correctly Ans.	Females Per Cent
Part I (General Concepts)	1200	567	47.25	1700	885	52.06
Part II (Identification)	1200	354	29.50	1700	541	31.83
Part III (Important Men of Science)	600	205	34.17	850	262	30.82
Part IV (Definitions)	900	326	36.22	1275	524	41.09
Part V (Uses of Objects)	1200	417	34.75	1700	475	27.94
Part VI (Miscellaneous Facts)	2100	978	46.57	2975	1291	44.90
Total	7200	2847		10200	3978	

CONCLUSIONS

The important conclusions derived from this investigation were:

1. The majority of all the students participating in this study have had courses in general science, biology, algebra, geometry, and mathematics.
2. Only 6.66 per cent male and 4.71 per cent of female students have had a course in physics.
3. More than half of the male and female students have had a course in chemistry.
4. Less than 13.33 per cent of the male students and less than 4.71 per cent of the female students made scores equal to or better than the National norm for students in the ninth month of the ninth grade.
5. The mean score for the male students was 49.01 and for the female students 46.93. The median for the entire group—both males and females—was 47.79. A comparison of these medians with the National median shows that the majority of the students participating in the study have reached the seventh grade in mastery of subject-matter content in general science.
6. Twenty per cent of the female students and less than 36.66 per cent of the male students made scores below the National norm for students beginning the seventh grade. The National median for beginning students in the seventh grade is 38.
7. None of the students, both males and females, have mastered the subject-matter content in general science as shown by the data in Table III.

SCIENCE TEACHING IN NEGRO HIGH SCHOOLS IN LOUISIANA

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THIS report is based on questionnaires and visits made during the second semester of the school year 1953. The major purposes of this study were to ascertain the objectives and years of teaching experience of science teachers in Negro high schools in Louisiana; to utilize the data to improve the physical science instructional program at Southern University; and finally to improve the science instructional program in Negro high schools in Louisiana.

Questionnaires were sent to sixty Negro high schools in the state. Of these, fifty questionnaires were completed and returned by thirty-eight schools.

SCIENCE TEACHERS

Table I shows the number of science teachers surveyed by sex.

TABLE I

NUMBER OF SCIENCE TEACHERS

Sex	Number	Per Cent
Females	16	32
Males	34	68
Total	50	100

TABLE II

NUMBER AND PER CENT OF SCIENCE TEACHERS TEACHING ONE OR MORE SCIENCE COURSES AND THOSE ALSO HAVING COACHING DUTIES

Teaching Load (Science Courses)	Number		Per Cent		
	Males	Females	Males	Females	Total
Number of teachers teaching only one science course	2	4	4	8	12
Number of teachers teaching two science courses	11	4	22	8	30
Number of teachers teaching three science courses	9	4	18	8	26
Number of teachers teaching four or more science courses	12	4	24	8	32
Total	34	16			100
Number of science teachers having coaching duties in addition to teaching one or more science courses	11	4	2	8	30

These thirty-eight schools were located in thirty-five cities and towns in the state. The range of enrollment of the schools represented was from 83 to 1991 pupils. It will be noted from Table I that a greater percentage of the science teachers surveyed were males.

Table II shows that of the science teachers surveyed 12 per cent taught only one science course, and 30 per cent not only taught one or more science courses but also had coaching duties in addition to teaching one or more science courses. They were teaching in high schools with an enrollment ranging from 83 to 953 pupils.

Table III shows the range of teaching experience by subjects, and the number of teachers teaching those courses.

Data in Table III shows that the teachers surveyed have experience in terms of years in handling the courses listed except for trigonometry, and that the majority of the teachers teach courses in algebra, biology, chemistry, general science, general mathematics, and plane geometry.

From Table IV, it will be noted that only 4 per cent of the teachers were concerned with developing scientific attitudes, and only 12 per cent were concerned with developing functional concepts and providing opportunities for growth in basic instrumental skills.

TEACHING AIDS

Table V shows the teaching aids used in science by number and per cent of science teachers.

TABLE III

YEARS OF TEACHING EXPERIENCE BY SUBJECTS AND THE NUMBER OF TEACHERS TEACHING RESPECTIVE SCIENCE COURSES

Subjects	Range of Years of Experience	Number of Teachers Teaching Course	Per Cent
Algebra	1 year to 10 years	19	50
Biology	1 year to 15 years	24	63
Chemistry	½ year to 9 years	13	34.2
General science	1 year to 9 years	23	60.5
General mathematics	1 year to 20 years	20	52.6
Plane geometry	1 year to 10 years	21	55.3
Solid geometry	8 years	1	2.63
Trigonometry	1 year	1	2.63
Physics	3 years to 5 years	3	7.9

TABLE IV

NUMBER AND PER CENT OF OBJECTIVES BY SCIENCE TEACHERS IN THE STATE

Objectives [1]	Number of Teachers	Per Cent
1. To provide for growth in the development of scientific attitudes	2	4
2. To provide opportunities for growth in the functional understanding of facts	12	24
3. To provide opportunities for growth of skill in the use of elements of scientific method	11	22
4. To provide for growth in the development of appreciations	7	14
5. To provide for growth in the development of interests	7	14
6. To provide for development of functional concepts	3	6
7. To provide for growth in the functional understanding of principles	3	6
8. To provide opportunity for growth in basic instrumental skills	8	16

[1] Commission on Reorganization of Secondary Education, *Report of Subcommittee on the Teaching of Science,* U. S. Bureau of Education Bulletin, No. 36, Washington: Government Printing Office, 1920.

TABLE V

AIDS USED BY SCIENCE TEACHERS

Teaching Aids Used	Number of Science Teachers	Per Cent
Motion picture	23	46
Slidefilms	19	38
Public and commercial museum	2	4
Micro-projectors	9	18
Cases and cabinets display	20	40
Bulletin board and blackboard	33	66
Aquariums, terrariums, and receptacles for growing plants	20	40
Field trips	29	58

TABLE VI

EXTRACURRICULAR ACTIVITIES IN SCIENCE SPONSORED BY SCIENCE TEACHERS

Science Clubs	Number Sponsored by Science Teachers	Per Cent
General science	15	30
Chemistry	1	2
Biology	11	22
Radio	5	10
Nature	7	14
Mathematics	1	2
Photography	2	4

It will be noted in Table V that 66 per cent of the science teachers made use of bulletin boards and blackboards, 58 per cent made use of field trips, and only 4 per cent made use of public and commercial museums as aids in teaching their respective science courses.

Data in Table VI show that a large per cent of the science teachers surveyed do not sponsor any extracurricular activities which would aid in the learning of science and help create the desired interest in science. Table VI also shows that 30 per cent of the science teachers sponsor gen-

eral science clubs, and 22 per cent of them sponsor biology clubs.

ANALYSIS OF DATA

From the data Table II the majority of the science teachers teach more than one science course, and a large per cent of the science teachers represented have coaching duties in addition to their teaching load. This suggests the reason why a large per cent of Negro college students who have been graduated from Negro high schools in Louisiana generally do below average academic work in both pure and survey science courses taught at Southern University.

Data as shown in Table III suggest that only in terms of years of teaching experience are the majority of the science teachers qualified to teach the science courses listed.

Table IV also show that too few science teachers have objectives of any kind in teaching their respective science courses. This suggests that the science teachers surveyed either are lackadaisical about their work or are not familiar with the major objectives of science teaching in high schools as outlined by the committee[2] on the teaching of science.

Table V shows that too few science teachers make use of public and commercial museums. This explains perhaps why the attitudes of a large number of college students seem to be negative toward science. It also suggests why the interests of a large per cent of college students in science courses are at a very low point.

Table VI shows also that there is a great need for science teachers to develop clubs in chemistry and mathematics as a means of creating interest in these subject matter areas.

[2] *Ibid.*

CONCLUSIONS AND RECOMMENDATIONS

In so far as the techniques employed in this study may be valid the following conclusions are offered:

1. Fifty-eight per cent of the science teachers teach more than three different science courses.
2. Thirty per cent of the science teachers have coaching duties in addition to their duties of teaching science courses.
3. The number of years of experience in teaching science courses range from one-half year to twenty years.
4. Only forty-six per cent of the science teachers were concerned with providing opportunities for growth in the functional understanding of facts and for growth of skill in the use of elements of the scientific method.
5. Majority of the science teachers make use of the teaching aids listed in this study.
6. Fifty-two per cent of the science teachers sponsor general science and biology clubs as extra-curricular activities in science.
7. Of the teachers surveyed less than 15 per cent teach courses in physics, trigonometry, and solid geometry.

In so far as the conclusions of this investigation are valid, the following recommendations seem justified:

1. That science teachers be relieved of coaching duties, so that more time and effort can be devoted to developing good science courses.
2. That science teachers teach not more than two different science courses within any one semester. This practice would give the science teacher more time to develop scientific attitudes and at the same time give and guide high school pupils to a greater array of scientific information.
3. That as a means of obtaining objectives for science courses taught, science teachers study the needs of their pupils and the trends in our present day society relative to the part played by the use and knowledge of science.
4. That more science teachers make use of community resources as a means of giving the high school pupil needed and desired experiences and knowledge of things about him.
5. That more high schools in the state offer good courses in physics, chemistry, trigonometry, and solid geometry.

In summary, there is an urgent need for improving the entire high school science program throughout the state.

STUDY AND DEVELOPMENT OF A COURSE FOR TENTH YEAR SCIENCE IN VOCATIONAL HIGH SCHOOL FOR MECHANICAL, ELECTRICAL AND STRUCTURAL TRADES

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THE PROBLEM

FOR some time we have been thinking about a course in tenth year science which would be suitable for the kind of boy who came to the vocational high school. This pupil, his needs, and interests, problems and concerns had to be handled in a more effective way. More and more, he was beginning to look like the average person in the community. He no longer was a special segment of the population. He represented the common man in the population.

He *had* to stay in school until he was 17 years old. In many cases he would stay in school if the material met his needs and interests. Thus the problems of the vocational high school boy began to take shape. To devise a course for him required that the following needs be met:

1. The course must be related to the boy's life based on vocational needs and general interest.
2. Since this type of pupil is interested in mechanical things, a wide experience of a nonverbal nature must be offered him. Our pupils are often lacking in experiences with things that children in higher socio-economic levels have had. It is necessary to broaden their experiences through visits, movies, experiments, etc.
3. Since many plan to be mechanics, and this is a world of science and technology, all material should be written with that idea in mind.
4. Examining pupils for I.Q.s, arithmetic computation abilities and reading abilities would provide us with a concrete idea of what we meant by an ('average') population.
5. In educational circles, the matter of I.Q. had been questioned as an absolute measure of future accomplishment. In the experience of teachers it has been found that pupils carried themselves socially and often intellectually beyond indicated test levels.
6. It also has been found that emotional factors have much to do with one's lack of intellectual accomplishment. This area requires a guidance attitude and mental hygiene point of view.
7. It is also necessary to meet the needs of the early school leavers. With reference to a terminal course, the needs and interests of these pupils must be examined with a view to satisfying the problem of youths who will probably not return to some educational institution for further schooling in later life. They represent our laborers, factory help, mechanics, and mechanics' assistants. They will do much of the world's physical work.
8. Since most pupils are not certain of their choice of trades or do not possess sufficient aptitude for their chosen activity, the tenth year should be looked upon as an additional exploratory year, and also as laying a scientific foundation for advanced work in the chosen trade. This would be particularly true for the early school leavers.
9. The vocational and educational guidance aspects of our work and courses should be emphasized. Observations and tests made of the fourth-term pupil were used as a guide to determine the level at which material should be written. It was found that our pupils had the following characteristics:

Reading grade (median)-7.24
Arithmetic computation (median)-6.74
Intelligence quotient (median)-88.8

However the range in most classes for reading grade was 11th year to 3.5 year; arithmetic computation—from 12th year to 4th year; and intelligence quotient from 126 to 55.

Such a lack of homogeneity offers the greatest problem. To the teacher, this tremendous range of ability, this wide variation in individual differences is the most serious of all the problems. A suggestion that the activity approach with an interrelated or core curriculum based on vocational interests offers a possible solution. Certainly here is an opportunity for having each pupil work at his own speed and learn to work cooperatively and democratically with his fellow pupils. It offers the slower boy the opportunity of listening to and working with the pupil of better ability and greater accomplishment.

However we do not agree that all work should be chosen because of the so-called interests and needs of pupils. Interests and

needs change with sex maturity and social growth. To have direction and at the same time be functional requires a course with broad subject matter and multiple appeals.

CRITERIA FOR COURSE

With this in mind, the course in science for the tenth year is written.

1. For the general education of all pupils.
2. Directed to the vocational needs of many trades.
3. Directed toward understanding the complicated scientific and technological world.
4. Concerned with the drives of young people who will participate in the community affairs on their level.
5. To be exploratory in its approach.
6. To be interested in the attitudes of youngsters who will leave school.
7. To be directed towards keeping pupils in school as long as possible.

THE COURSE

The course will be motivated and developed in terms of actual devices and not the gadget approach. It will be built around three units.

1. Energy and its transformations.
2. Machines and the use of energy to make man's work easier.
3. Materials the mechanic must know and use to perform the work of the world.

A REPORT TO THE NARST ON THE RELATIONSHIPS WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FOR THE YEAR 1955–56 *

GEORGE GREISEN MALLINSON
Western Michigan College, Kalamazoo, Michigan

INTRODUCTION

DURING the past year the NARST has continued the types of relationships with the AAAS that were established during the year 1954–55. Hence this report will encompass three areas, namely (a) Activities with the Cooperative Committee on the Teaching of Science and Mathematics of the AAAS, (b) Participation at the Meetings of the AAAS Council, and (c) Symposium on Science Education Research at the Convention of the AAAS in Atlanta, Georgia in December 1955.

ACTIVITIES WITH THE COOPERATIVE COMMITTEE ON THE TEACHING OF SCIENCE AND MATHEMATICS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Meetings of the Cooperative Committee

Since the last meeting of the NARST the Cooperative Committee has met on two occasions, namely, (1) in the Board of Directors Room, American Chemical Society, Washington, D. C., October 21 and 22, 1955; and (2) at the Horace Rackham School of Graduate Studies, Ann Arbor, Michigan, March 2 and 3, 1956. As usual the place of meeting is in accord with the policy of meeting in Washington for the Fall Meeting and in the Midwest for the Spring Meeting. The cost of your representative's attendance at the meetings was borne by sources other than the NARST treasury.

Personnel of the Cooperative Committee

A number of changes have taken place in the personnel of the Cooperative Committee since your representative made his last report. As of March 7, 1956 the officers and members were as follows:

Officers:
Chairman:
Dr. J. W. Buchta
Department of Physics
University of Minnesota
Minneapolis, Minnesota
Vice-Chairman:
Dr. Harvey Sorum
Department of Chemistry

* A report made by the NARST Representative on the Cooperative Committee of the AAAS at the Twenty-Ninth Annual Meeting of the National Association for Research in Science Teaching at the Hotel Sherman; Chicago, Illinois, April 23, 1956.

University of Wisconsin
Madison 6, Wisconsin

Secretary:
Dr. Bernard B. Watson
Operations Research Office
Johns Hopkins University
7100 Connecticut Avenue
Chevy Chase 15, Maryland

Members:

Academy Conference of the AAAS:
Mr. Wayne Taylor
Extension Teaching and Field Service Bureau
University of Texas
Austin, Texas

American Association of Physics Teachers:
Dr. Fletcher G. Watson
Graduate School of Education
Harvard University
Cambridge 38, Massachusetts

American Astronomical Society:
Dr. Wasley S. Krogdahl
Dearborn Observatory
Northwestern University
Evanston, Illinois

American Chemical Society:
Dr. Harvey Sorum
Department of Chemistry
University of Wisconsin
Madison 6, Wisconsin

American Geological Institute:
Mr. Theodore Woodward
4207 Hewett Avenue
Silver Spring, Maryland

American Institute of Physics:
Dr. J. W. Buchta
Department of Physics
University of Minnesota
Minneapolis, Minnesota

American Nature Study Society:
Dr. Richard L. Weaver
School of Natural Resources
University of Michigan
Ann Arbor, Michigan

American Society for Engineering Education:
Professor W. E. Restemeyer
University of Cincinnati
Cincinnati 21, Ohio

American Society of Zoologists:
Dr. L. V. Domm
Chairman, Department of Anatomy
Stitch School of Medicine
Loyola University
Chicago 12, Illinois

Association of Geology Teachers:
Dr. Arthur L. Howland
Chairman, Department of Geology
Northwestern University
Evanston, Illinois

Board of Directors of the AAAS:
Dr. Harold K. Schilling
Dean, Graduate School
Pennsylvania State University
University Park, Pennsylvania

Botanical Society of America:
Dr. Fred H. Norris
Botany Department
University of Tennessee
Knoxville 16, Tennessee

Central Association of Science and Mathematics Teachers:
Mr. W. H. Edwards
Central High School
2425 Tuxedo Avenue
Detroit 6, Michigan

Division of Chemical Education of the ACS:
Dr. Fred B. Dutton
Department of Chemistry
Michigan State University
East Lansing, Michigan

Engineers Joint Council:
Dr. Henry H. Armsby
U. S. Office of Education
Department of Health, Education and Welfare
Washington 25, D. C.

Mathematical Association of America:
Dr. David Blackwell
Department of Mathematics
University of California
Berkeley 4, California

National Association of Biology Teachers:
Brother G. Nicholas, F.S.C.
114 Hanover Street
Cumberland, Maryland

National Association for Research in Science Teaching:
Dr. George G. Mallinson, Dean
School of Graduate Studies
Western Michigan College
Kalamazoo, Michigan

National Council of Teachers of Mathematics:
Mr. Henry W. Syer
School of Education
Boston University
Boston 15, Massachusetts

National Science Teachers Association:
Dr. Morris Meister
Principal, High School of Science
120 East 184th Street
New York 68, New York

Section Q (Education) of the AAAS:
Dr. Harold E. Wise
University of Nebraska
Lincoln, Nebraska

Director of the Science Teaching Improvement Program:
Dr. John R. Mayor
American Association for the Advancement of Science
1515 Massachusetts Avenue, N. W.
Washington 5, D. C.

Activities of the Cooperative Committee

At both the Washington and Ann Arbor Meetings most of the time was spent discussing the Science Teaching Improvement Program (STIP) described as the Science Teaching Emergency Program in last year's report.[1] Since the last report STIP has developed from a series of tentative proposals to a program subsidized by a $300,000 grant from the Carnegie Corporation. The program it must be made clear, while initiated in the Cooperative Committee, is not an agency of that Committee. STIP is responsible only to the Board of Directors of the AAAS. While the director, Dr. John R. Mayor, on leave from the University of Wisconsin, may request aid and advice from the Cooperative Committee and its member societies, neither he nor the program is obligated to respect such aid or advice.

The most recent publication of STIP indicates the activities to encompass the following:[2]

1. ". . . the AAAS plans an organized effort to bring the facts concerning the critical shortage of high-school teachers of science to the attention of college and university departments of science and mathematics and to urge their more active participation in the recruitment, training, and encouragment of high-school teachers of science and mathematics.

"What is appropriate on one campus may not be appropriate on another. The following list, therefore, includes what appear to be desirable activities, but the details must be expected to differ from one institution to another.

"(1) Collegiate departments of science can examine, and frequently improve, their undergraduate courses and major requirements from the standpoint of their appropriateness for future high-school teachers.

"(2) Working with departments of education and state school officials, they can revise certification requirements to place greater stress on subject-matter preparation of prospective teachers.

"(3) They can develop courses suitable for high-school teachers who return to the campus for summer work. In many states a teacher with graduate work or a master's degree qualifies for a salary increase. The undergraduate work of many teachers who would like to get such increase is not adequate, however, for enrollment in the traditional graduate courses in science and mathematics. Turned away by departments of science, they concentrate in education, in which they can receive graduate credit. This situation creates a problem for science departments: they do not wish to water down their advanced courses; neither do they wish to give graduate credit for their elementary courses. Yet unless they make some adjustment, they are missing an opportunity to raise the level of high-school teaching and improve the preparation of future students in their own fields."

2. "Special accelerated programs in education should be arranged for senior undergraduate students who wish to qualify for teaching positions before the beginning of the next academic year. For students in independent liberal arts colleges without departments of education, cooperative arrangements with departments of education in nearby institutions may need to be worked out. In any case, institutions of higher education should take the initiative in setting up such accelerated programs and in bringing them to the attention of interested students.

"Many states provide for emergency teaching certificates that make it possible for a partially qualified individual to obtain immediate teaching employment and to satisfy the requirements for a standard teaching certificate while employed. In some cases accelerated programs in educa-

[1] Mallinson, George Greisen, "A Report to the NARST on the Relationships with the American Association for the Advancement of Science for the Year 1954–55." *Science Education*, XL (March 1956), 155–7.

[2] *Science Teaching Improvement Program.* Washington, D. C.: American Association for the Advancement of Science (undated). Pp. 24.

tion leading to emergency certification may be possible; in others, especially those found among college graduates out of school for some years, supplementary or refresher work in science may be more appropriate. Colleges and universities, in cooperation with certification authorities, can take the initiative in establishing such programs and in bringing them to the attention of interested individuals in the regions that they serve.

"The AAAS plans to study the effectiveness of tapping these resources of potential science and mathematics teachers, to collect information on what is already being done toward that end by individual institutions, and to hold a series of state conferences of scientists, educators, and state certifying officials to stimulate additional efforts toward the development of emergency programs for the training of science and mathematics teachers."

3. "To satisfy expanding requirements for the future, vigorous measures will be necessary to interest a considerably larger number of potentially qualified students in preparing for teaching careers.

"Many steps may be taken toward the accomplishment of this objective. Among these are (i) the preparation and dissemination of appropriate guidance materials on mathematics and science teaching; (ii) the promotion of vocational guidance programs through assemblies, radio, and television; (iii) the utilization of scientists and engineers as counselors of students with scientific interests; and (iv) the encouragement of high-school science clubs, science fairs, and junior academies of science.

"An important element in the development of a recruiting effort is knowledge of what it is that people find attractive and unattractive in the field for which one is recruiting. Some of these factors are already known insofar as they concern the field of teaching, but current and better information is desirable. Consequently the AAAS plans to make a study both of the factors that attract people into teaching, and of the factors that are important in influencing teachers to turn to other kinds of work. The information from the study can be used, not only in guidance and recruiting, but also, to some extent, in suggesting changes in school policies and arrangements that would make teaching more attractive."

4. ". . . support the principle that beginning salaries, rates of salary advance, and salary ceilings for teachers should be comparable to those available to other professional personnel of equivalent training. Obviously the AAAS cannot bring about such a sweeping change; this can be accomplished only by widespread local action at the community level. What the AAAS can do is to enlist the aid of state academies of science and other state and local scientific groups in bringing to clearer public attention the need for higher salaries for teachers and the special problems that exist in the fields of science and mathematics. Moreover, its 50,000 members and the members of its 260 affiliated and associated societies could lend their influence to these efforts in their own communities.

"The salaries of teachers of science and mathematics are usually controlled by general salary schedules. It is doubtful that salaries of science and mathematics teachers could be raised above the general levels, and debatable whether they should be. Efforts to increase the total income of science teachers are, however, being made by methods other than salary increases. Therefore a study is also contemplated of the various ways in which science teaching can be made more attractive financially by such devices as year-round employment, summer employment in science-related industries, or additional pay for directing student research projects, science clubs, science fairs, and other activities. Most salary schedules at present do not provide for increases on a merit basis. Although it is recognized that such differential scales are debatable, consideration of this prob-

lem by scientists might lead to a more satisfactory solution."

5. "The AAAS, both as an association and through its individual members, can bring to the attention of appropriate groups the need for improving the conditions under which science teachers work. It will investigate the effectiveness of the use of teaching assistants and of such instructional aids as motion pictures, radio, and television in increasing teaching efficiency and providing the teacher with more attractive working conditions. It will give special attention to the adjustment of teaching load, so that a more effective job may be done, particularly in connection with laboratory instruction.

"Believing that closer affiliation with organized science and the resultant enhancement of professional *esprit* would benefit teachers, the AAAS plans to encourage the attendance of teachers at scientific meetings and will support the provision of time off and reimbursement of travel expenses to encourage such attendance."

6. "The AAAS . . . plans to institute an annual program of awards to outstanding teachers. The teachers to be honored will be those who, over a period of years, have been recognized in their schools and communities as exceptionally effective, whose knowledge of science and mathematics approximates that of the master's degree level, and who have, through writing or other means, been of substantial help to their fellow-teachers. Such teachers are good "professionals" and merit higher prestige than is accorded to teachers genally. We propose to honor them with citations as Distinguished Service Teachers. Since these citations are intended not only to reward excellence but also to call public attention to the importance of good teaching, the citations will be awarded in the teachers' own schools.

"If financial backing can be secured, even more might be done. For example, the teachers selected for citation might be given monetary awards; or the expenses might be underwritten for each year's group to attend the annual meeting of the AAAS.

"The scope of these plans is flexible. The number selected each year should be small enough to make the citation a real honor, yet large enough to make the motivation and prestige values as widely effective as possible. Perhaps 100 Distinguished Service Teachers a year would be a good starting level.

"Intelligently administered, rank and honors are not only an award to those who receive them but an inspiration to those who aspire to them. For many individuals, and particularly those who are sincerely attracted by the opportunity to guide the intellectual development of young people, the respect accorded the teacher may provide the best measure of the value that society places on teaching.

7. "The plans described here are designed to retain experienced science teachers in the clasroom and to increase the number of young people who prepare to teach science. Even if these goals are achieved, the greatly increased high-school enrollment of the next few years will in all probability necessitate the use of many science teachers with less than adequate preparation. It is proposed, therefore, to undertake a pilot study of a method for upgrading the work of relatively inexperienced and inadequately prepared teachers.

"The plan provides for the employment in each of several geographic regions of two competent science or mathematics teaching counselors—expert consultants—who will tutor, assist, and serve as a source of information and help to the less-experienced and less-competent science teachers of the region. These consultant teachers would have no administrative supervision over their colleagues, and would be employed only in regions in which supervisory help in science and mathematics is not already available within the school system.

"If one such consultant were made available to each group of 20 to 25 teachers,

the increase in staff would amount to only 4 or 5 per cent. The number of teachers will increase anyway; perhaps this type of increase would be more effective than others. It seems worth while to test the hypothesis that the total effectiveness of instruction will be greater with such consultants than if the same individuals simply taught classes all day.

"If this hypothesis is borne out, it is hoped that the demonstration will encourage school systems, state departments of education, and colleges and universities to assume permanent responsibility for providing continuing consultant services in science and mathematics to nearby high-school teachers of those subjects."

Dr. Mayor has worked assiduously since his taking over the reins of STIP in September 1955. He has traveled widely and appeared before many organizations to describe the aspects of the program. So far the activities seem chiefly to involve publicizing STIP. The success of such activities in producing the desired results is a matter which only the future will indicate.

As stated in last year's report, your representative recommends that the NARST support the program. He has some major reservations about "Awards for Distinguished Teachers" and "Consultants for Teachers." He doubts that the proponents on the Cooperative Committee of these suggestions are sufficiently aware of the situation in science teaching outside large urban centers, to recognize the many practical difficulties. However, these aspects of the program are not sufficiently deleterious to warrant rejection of the whole.

The second meeting of the Cooperative Committee, namely, the one in Ann Arbor was held in cooperation with a STIP program for college science teachers of Michigan. About sixty persons were in attendance and were acquainted with various aspects of the STIP program. The extent to which tangible solutions to the problems of science teaching will be forthcoming, as indicated earlier, is a matter of conjecture. There is no doubt however that the publicity has been most valuable.

AAAS Traveling Science Library

Another program of the AAAS to which the Cooperative Committee has given assistance is the Traveling High School Science Library Program.

"The Traveling High School Science Library Program is administered by the American Association for the Advancement of Science. It is supported, in 1955–56, by a grant from the National Science Foundation. The program has been developed and the books selected with the advice and suggestions of the U. S. Office of Education, the National Education Association and its affiliated organizations, the New York Public Library, and over 350 scientists, science teachers and librarians.

"The objectives of the program include: stimulating an interest in reading science books by high school students; broadening the science background of students; and assisting students who are interested in science in choosing a career.

"The traveling libraries consist of 150 books, divided into six units of 25. Each unit of 25 books represents a variety of science subjects. The 150 volumes include but a fraction of the number of books available, suitable, and recommended. Eleven complete sets are being circulated in 1955–56 and a twelfth set is being used for demonstration purposes at meetings of scientists, teachers and librarians.

"None of the books in the libraries were written exclusively for young people. They are all adult books which can be read and understood by persons with little or no background in science; in the case of some books, a knowledge of the rudiments of algebra and plane geometry will be necessary. No more than five books of the total number may constitute a challenge to the superior student.

"Biographies and autobiographies, history of science, and books on applied science predominate in the collection.

"It is believed that the interest of students is stimulated most readily by such science-in-action books. A few textbooks have been included because no general book was found that covered the same subject matter adequately, and because the textbooks selected also are suitable for general information reading.

"This science library program is experimental. During 1955–56, a total of 66 high schools located in 12 states will participate. Each of these high schools has an enrollment of less than 350 students in grades 9 to 12 inclusive. A large proportion of the high school students in the United States are enrolled in similar small schools where they do not have access to school or public libraries comparable, with respect to their collections of science books, to libraries in larger schools and in metropolitan areas.

"Each school will receive one unit of 25 books at a time which may be used for approximately four weeks while classes are in session. At the end of the year all six units, or the total collection of 150 books, will have been used at all of the 66 participating schools.

"The books are numbered serially from 1 to 150; the six units of 25 books each are designated by the letters A, B, C, D, E and F. Both letter and number appear on each book, so for example, it will be readily understood that book numbered B-35 is to be found in the second unit.

"The American Association for the Advancement of Science will be interested in receiving the comments of high-school teachers, students, and librarians concerning the program or with respect to individual books in the libraries."

Your representative is thoroughly sold on this program. He suggests that the NARST give wholehearted support to it and provide any assistance which may be requested.

Summer Institutes for Science Teachers

The development of summer institutes for science teachers in colleges and universities in collaboration with various foundations and industries has proved to be a most interesting development. In such institutes teachers who prove to be highly qualified are subsidized for a summer session's study in science courses designed to bring them up to date. In many cases they are paid a stipend for such attendance. Such institutes have been sponsored, among others, by the American Association of Physics Teachers, National Cancer Institute, Atomic Energy Commission, Shell Oil Corporation, and National Science Foundation. All these programs no doubt serve to publicize the problems of science teaching and benefit those attending greatly.

Your representative, however, is concerned with the fact that those generally given scholarships are those whose qualifications are already high. There may be some need for reexamining the functions of some of these institutes to determine whether *able* but inadequately trained science teachers who can profit greatly by additional training might not be served.

Educational Television

The various fields of mass media of communication, especially in the areas of commercial and closed-circuit television are now under study. Some special research is being carried out in these areas with respect to science. The Fund for the Advancement of Education recently granted the National Association of Secondary School Principals the sum of $600,000 part of which is to be used in testing out closed-circuit television in the classroom.

Unfortunately there is little or no precedent or tradition in this field. Findings are few. However within the next few years there are likely to be great developments that have implications for classroom teaching in science.

Pre-Service Training of Science Teachers

One of the most significant actions taken at a Cooperative Committee Meeting, in the opinion of your representative, deals with the pre-service training of science teachers. The following excerpt from the minutes describes the action:

"Bernard Watson made a plea for much greater attention to the preservice preparation of science teachers. He expressed the opinion that most of the STIP effort as well as that of the National Science Foundation is being devoted to remedying the deficiencies in the preparation of inservice science teachers who were not properly trained initially and that greater dividends would be paid through the development of an adequate undergraduate program for the training of secondary school science teachers. This, he maintained, could not be accomplished by a redistribution of credit requirements among fields of study but would require the development of entirely new courses in science at the intermediate college level. *Schilling moved the appointment of a 'strategy committee' to plan a program for attacking the problem of proper undergraduate training of science teaching.* The motion was approved unanimously. It was suggested that the membership of this committee should include some 'pure' scientists. Weaver suggested, further, that the National Science Foundation be urged to devote some of its resources to research on the preservice training of science teachers. Behnke called attention to the activity of the National Research Council's Committee on Educational Policies in connection with a redesign of the undergraduate program in biology. Schilling made a preliminary report for the Subcommittee on Accreditation and Teacher Certification. He referred to a previous report on this subject published in 1946 by the Committee. He indicated that his subcommittee planned first to study the recommendations made by the Committee in the 1946 report. (A copy of this report has been sent to each member of the Committee in Attendance at Ann Arbor.) The subcommittee then plans to look into current laws and practices of the several states on matters concerned with teacher certification. Schilling pointed out that some states impose upper limits on the number of credits acceptable in the field of specialization of the teacher and that several states are currently considering an increase in the requirements in professional education. It was pointed out also that colleges and universities often set their own requirements for recommending a student for teacher certification. In many cases the number of credits in education required by the teacher training institution is higher than the state requirement. Behnke suggested that the subcommittee look into the NABT and Ohio recommendations as well as the Michigan proposals which are reported in the January 1956 issue of School Science and Mathematics. Weaver suggested that the subcommittee undertake a study of the procedures which must be followed for changing certification requirements in the several states."

Your representative believes this to be an excellent idea especially with respect to the development of new courses at the intermediate level. This activity has long needed doing. It is an area in which the NARST has long been interested and one which your representative has recommended to the Cooperative Committee on many occasions as being worthy of study.

PARTICIPATION AT THE MEETING OF THE AAAS COUNCIL

As usual at the annual Convention of the AAAS at Atlanta, Georgia in December, your representative attended the meetings of the AAAS Council at which the NARST, as an affiliate, has a voice. While a number of significant actions were taken only one seems to be of direct import to the NARST, namely, the matter of holding meetings in areas where segregation is practiced.

Frankly, your representative stated to several members of the Board of Directors of the AAAS *prior* to the Atlanta meeting that the NARST would oppose meeting in any city in which AAAS members because of race, creed or color, would be restricted in any way from the free activity that typifies science. However, the decision was made to meet in Atlanta. Several societies as a matter of principle refused to participate at the meeting. While all meetings were open to all persons, and no incidents were apparent, the "cultural policies of the South" prevailed in all other ways.

Your representative is pleased to state that actions of the AAAS Council Meetings and a later vote have established the policy that the AAAS shall never again meet in a city where segregation is practiced as a policy. The NARST recognizes that subtle practices are evident in certain places and that they are to be decried unequivocally. However, the policy, at least represents an important step forward. The vote of your representative obviously supported the established policy as did the vast majority.

SYMPOSIUM ON SCIENCE EDUCATION RESEARCH AT THE CONVENTION OF THE AAAS IN ATLANTA, GEORGIA IN DECEMBER, 1955

At the Atlanta Convention in 1955 again the Joint Science Teaching Societies sponsored a symposium on Science Education Research such as the one that proved to be so popular at Berkeley, California in 1954. The symposium as listed in the official program was as follows:

SYMPOSIUM: RECENT RESEARCH IN SCIENCE EDUCATION

Arranged by George G. Mallinson, Western Michigan College, Kalamazoo, Michigan

Waldo W. E. Blanchet, Fort Valley State College, Presiding

1. Survey of Research in Elementary School Science Education, Clark Hubler, Wheelock College.
2. Implications of Research in Elementary School Science Education. Julian Greenlee, Florida State University.*
3. Survey of Research in Secondary School Science Education. Jacqueline Buck Mallinson, Kalamazoo, Michigan.
4. Implications of Research in Secondary School Science Education. Hubert Evans, Teachers College, Columbia University.
5. Survey of Research in College Level General Education Science. Edward K. Weaver, Atlanta University.
6. Implications of Research in College Level General Education Science. Woolford B. Baker, Emory University.
7. Summary. George G. Mallinson, Western Michigan College.

In toto about 180 persons attended and only six left before the end of the entire program. In general, it was accepted with enthusiasm.

At the New York Convention in 1956

At present Dr. Nathan Washton and your representative are working on the program of the Joint Science Teaching Societies for the AAAS Convention to be held in New York in December 1956. A symposium similar to the ones at Berkeley and Atlanta is being planned. *Again, the Symposium is not an NARST affair.* Rather it is a meeting that will involve the joint sponsorship and cooperation of all the science teaching societies affiliated with the AAAS. The NARST will however take the major responsibility for developing the program. It is hoped that it will be as successful as the last ones.

SUMMARY

Your representative is grateful to the NARST for being allowed to represent it in the activities of such an august body as the AAAS. While he does not always agree with the policies adopted or actions taken in the AAAS meetings, the ultimate accomplishments have always far outweighed those actions with which he, and he is sure the NARST, would have believed undesirable. He strongly urges that the NARST continue its faithful support of the AAAS.

* Dr. Greenlee failed to appear. His position however was adequately handled by the other symposium members.

PROGRAM OF NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Twenty-Ninth Annual Meeting, April 21, 22, and 23, 1956
Hotel Sherman, Chicago, Illinois

OFFICERS OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

President: William C. Van Deventer, Chairman of the Department of Biology, Western Michigan College, Kalamazoo, Michigan

Vice-President and Program Chairman for 1956: Waldo W. E. Blanchet, Dean, Fort Valley State College, Fort Valley, Georgia

Secretary-Treasurer: Clarence M. Pruitt, University of Tampa, Tampa, Florida

Executive Committee Members:

Nathan S. Washton, Assistant Program Chairman for 1956, Director of Teacher Placement, Queens College, Flushing, New York

Kenneth E. Anderson, Dean, School of Education, University of Kansas, Lawrence, Kansas

PROGRAM

Saturday, April 21, 1956

Registration and Coffee Hours, Room 107, 8:30 A.M.–9:30 A.M.

I. *Investigations and Research Papers*, Old Chicago Room, 9:30 A.M.–11:45 A.M.

Waldo W. E. Blanchet, Chairman, Dean, Fort Valley State College, Fort Valley, Georgia

1. To Determine Some of the Factors Which Influence a Selected Group of College Freshmen to Choose Scientific Hypotheses
   Zylpha D. Hurlbut, Head of the Biology Department, Anderson College, Anderson, Indiana
2. Findings of a Study Pertaining to the Physical Science Education for Non-Science Students
   Elman A. Morrow, Professor of Mathematics and Engineering Drawing, William Jewell College, Liberty, Missouri
3. A Comparison of the Knowledges of Physical Science with Those of Biological Science of College Students
   George G. Mallinson, Director of Graduate Studies, Western Michigan College, Kalamazoo, Michigan

Intermission: 15 minutes

4. The Origin of Cell Principle: An Example of the Growth of Scientific Knowledge
   Auley A. McAuley, Assistant Professor of Biology, Michigan State University, East Lansing, Michigan
5. A Simplified Approach to the Problem of Scientific Methodology
   William C. Van Deventer, Head of the Department of Biology, Western Michigan College, Kalamazoo, Michigan

II. *Fourth Annual Review of Research in Science Education*, Old Chicago Room, 1:15 P.M.–3:15 P.M.

Clarence H. Boeck, Chairman, Head of the Science Department, University High School, University of Minnesota

1. Elementary Level
   H. Clark Hubler, Professor of Science Education, Wheelock College, Boston, Massachusetts
2. Secondary Level
   William B. Reiner, New York City Board of Education, Brooklyn, New York
3. College Level
   Edward K. Weaver, Professor of Science Education, Atlanta University, Atlanta, Georgia

III. *A Look Ahead at Science Education*, Old Chicago Room, 3:30 P.M.–5:00 P.M.

Nathan S. Washton, Chairman, Director of Teacher Placement, Queens College, Flushing, New York

1. Principles of Science
   Waldo W. E. Blanchet, Professor of Physical Science and Administrative Dean, The Fort Valley State College, Fort Valley, Georgia
2. Laboratory Instruction
   Kenneth A. Anderson, Dean of School of Education, University of Kansas, Lawrence, Kansas
3. Psychology and Philosophy of Science Teaching
   George G. Mallinson, Director of Graduate Studies, Western Michigan College, Kalamazoo, Michigan
4. Evaluation
   Clarence Nelson, Board of Examiners, Michigan State University, East Lansing, Michigan

5. The Role of the Professional Science Educator in View of the Shortage of Manpower in Science
   Ellsworth S. Obourn, Specialist in Science, Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

Sunday, April 22, 1956

IV. *Investigations and Research Papers*, Old Chicago Room, 9:00 A.M.–11:45 A.M.

Edward K. Weaver, Chairman, Professor of Science Education, Atlanta University, Atlanta, Georgia

1. Evaluation of the Ability of Teachers to Estimate the Reading Difficulty of Materials for Elementary Science
   Roma L. Herrington, Oliver School, South Bend, Indiana
2. A Determination of Criteria for Selection of Laboratory Experiences Suitable for an Integrated Course in Physical Science Designed for the Education of Elementary School Teachers
   Allen D. Weaver, Associate Professor of Physical Science, Northern Illinois State College, DeKalb, Illinois
3. A Workshop in Teaching Elementary Science—An In-Service Training Program for Teachers
   Clyde M. Brown, Associate Professor of Education, Southern Illlinois University, Carbondale, Illinois

Intermission: 15 minutes

4. An Experimental Study to Determine the Effect of a Selected Procedure for Teaching the Scientific Attitudes to Seventh and Eighth Grade Boys Th-ough the Use of Events in Science
   Paul Kahn, Chairman of the Science Department, Creston Junior High School, Bronx, New York
5. Explanations of College Students
   Mervin E. Oakes, Department of Biology, Queens College, Flushing, New York
6. The Manner in Which a Group of Ninth Grade General Science Students Analyze Selected Problems
   Edith G. Chess, Counseling Psychologist in Private Practice, Brooklyn, New York

V. *Needed Research in Science Education*, Old Chicago Room, 2:00 P.M.–4:30 P.M.

Thomas P. Fraser, Chairman, Head of the Department of Science Education, Morgan State College, Baltimore, Maryland

1. Analyst's Statement: Basic Aspects for Consideration in Strengthening Science Instruction Through Research in Science Education
   Herbert A. Smith, Director, Bureau of Educational Research and Service, University of Kansas, Lawrence, Kansas
2. What Research in Science Education Is Needed to Strengthen the Elementary School Science Program?
   Jacqueline Buck Mallinson, Science Consultant, Kalamazoo, Michigan
3. What Research in Science Education Is Needed to Strengthen the Secondary School Science Program?
   Clarence H. Boeck, Head of the Science Department, University High School, University of Minnesota

Intermission: 15 minutes

4. What Research in Science Education Is Needed to Strengthen the College Science Program?
   Herman H. Branson, Head of the Department of Physics, Howard University, Washington, D. C.
5. What Research in Science Education Is Needed to Strengthen the Teacher Education Program in Science?
   John S. Richardson, College of Education, The Ohio State University, Columbus, Ohio
6. Summary
   Vaden W. Miles, Department of Physics, Wayne University, Detroit, Michigan

Monday, April 23, 1956

VI. *Business Meeting*, Old Chicago Room, 9:00 A.M.–11:30 A.M.

William C. Van Deventer, Chairman, Head of Department of Biology, Western Michigan College, Kalamazoo, Michigan

1. Review of the Activities of the Association
   William C. Van Deventer, Head of Department of Biology, Western Michigan College, Kalamazoo, Michigan
2. Report of Committee on Educational Trends
   Abraham Raskin, Co-Chairman, Associate Professor of Physiology, Hunter College, New York, New York
   Jerome Metzner, Co-Chairman, Head of Department of Biology and Introductory Science, Bronx High School of Science, New York, New York
3. Relationships with the American Association for Advancement of Science
   George G. Mallinson, Director of Graduate Studies, Western Michigan College, Kalamazoo, Michigan
4. Reports of Special Committees
5. Treasurer's Report
   Clarence M. Pruitt, Secretary-Treasurer, University of Tampa, Tampa, Florida
6. Election of Officers for 1956–57

VII. *Annual Luncheon of N.A.R.S.T.*, Ruby Room, 12:15 P.M.

Address: Miss Ruth Moore, Science Journalist, Chicago Sun-Times, author of "Man, Time and Fossils," and other books in science
   Topic: "The Background of Science Journalism"

FOURTH ANNUAL REVIEW OF RESEARCH IN SCIENCE TEACHING

General Chairman:
- Clarence Boeck, Head of Science Department, University High School, University of Minnesota, Minneapolis, Minnesota

Level Committee Chairman:
- Elementary School Committee:
  - Clark Hubler, Chairman, Wheelock College, Boston, Massachusetts
  - Harry Milgrom, Vice-Chairman, Supervisor of Elementary Science, New York City Board of Education
- Secondary School Committee
  - William B. Reiner, Chairman, New York City Board of Education
  - Jerome Metzner, Vice-Chairman, Bronx High School of Science, New York City
- College Committee:
  - Edward K. Weaver, Chairman, Professor of Science Education, Atlanta University, Atlanta, Georgia
  - Clarence Nelson, Vice-Chairman, Board of Examiners, Michigan State University, East Lansing, Michigan

Coordinator with U. S. Office of Education:
- Herbert A. Smith, Director, Bureau of Educational Research and Service, School of Education, University of Kansas, Lawrence, Kansas

Committee on Needed Research
- Thomas P. Fraser, Chairman, Department of Science Education, Morgan State College, Baltimore, Maryland

Committee on Educational Trends:
- Abraham Raskin, Co-Chairman, Associate Professor of Physiology, Hunter College, New York, New York
- Jerome Metzner, Co-Chairman, Head of Department of Biology and Introductory Science, Bronx High School of Science, New York City

OFFICIAL MINUTES OF THE TWENTY-NINTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Hotel Sherman, Chicago, Illinois

April 23, 1956

President William C. Van Deventer presided at the Twenty-Ninth Annual Business Meeting of the National Association for Research in Science Teaching. The official minutes of the Twenty-Eighth Annual Meeting held at Teachers College, Columbia University, April 20, 1955 were approved as published in the March 1956 issue of *Science Education*. President Van Deventer presented the president's annual report.

Dr. Nathan S. Washton then reported on his attendance at the September 23, 1954, Washington meeting of the Future Scientists of America Foundation of the National Science Teachers Association. Dr. Abraham Raskin next made the report of the Committee on Educational Trends. The Educational Trends Committee made a recommendation that the various Level Areas Committees can best do what this Committee has been doing. Oakes made a motion that the report be adopted. Glidden seconded the motion. Motion carried.

Following this was the annual Cooperative Report made by George G. Mallinson (published in this issue of *Science Education*). Boeck made a motion that the report be accepted. Reiner seconded the motion. Motion carried.

Herbert A. Smith discussed possible research projects for NARST, with the possibility of research centers in the various states. Mallinson, Miles, Van Deventer, and Obourn joined in the discussion. Metzner made a motion that NARST set up a Committee to (1) propose research projects and to seek sponsorship for their promotion and (2) to promote effective liaison between NARST and other science education organizations for the purpose of pursuing objectives of mutual interest directed toward the promotion of activities of science education. Motion was seconded by Fraser. Motion carried.

Boeck as General Chairman made a report on the work and activities of the Fourth Annual Review of Research Com-

mittee. Comments were made by Smith, Hubler, Obourn, Boeck, Mallinson, Pruitt, Weaver, Fraser, and Miles. Mallinson made a motion that this year the unpublished studies be included by the present committee. Blanchet seconded the motion. Motion carried.

Treasurer Clarence M. Pruitt made the annual Treasurer's report as published in this issue of *Science Education*. Dr. Ellsworth S. Obourn made the Auditing Committee report, consisting also of members G. P. Cahoon and John C. Mayfield. The Treasurer's book was found to be correct and a motion was made by Miles and seconded by Smith that the report be accepted. Motion carried.

The report of the Nominating Committee was made by Chairman Edward K. Weaver. Other members of the Committee were Jacqueline Buck Mallinson and Vaden W. Miles. The Nominating Committee presented the following slate of officers for 1956–57:

President	Waldo W. E. Blanchet
Vice-President	Nathan S. Washton
Secretary-Treasurer	Clarence M. Pruitt
Executive Committee	William C. Van Deventer
	Thomas P. Fraser

Oakes made a motion that the report be accepted and that the Secretary be empowered to cast a unanimous ballot for those named by the Nominating Committee. McKibben seconded the motion. Motion was carried.

Brief remarks were made by President-Elect Blanchet.

A motion was made that the 1956 Business Meeting be adjourned. Motion carried.

EXECUTIVE COMMITTEE MEETING
APRIL 23, 1956

It was decided to hold the 1957 Annual Meeting at Atlantic City either preceding or following the American Association of School Administrators meeting in February.

Dr. George G. Mallinson was reappointed NARST representative to AAAS.

Dr. Ellsworth S. Obourn was named General Chairman of the Fifth Annual Review Committee. Professor Lillian Hethershaw Darnell was named Chairman of the Elementary Level Committee, Professor George T. Davis for the Secondary Committee, and Professor Edward K. Weaver for the College Level Committee.

A Liaison Committee to work with national agencies for Funds and Projects for the Promotion of Research in Science Teaching was appointed by naming Washton, Smith, Mallinson, Obourn, and Pruitt to the Committee. Meeting adjourned.

CLARENCE M. PRUITT

DINNER MEETING

Members of NARST attending the annual dinner meeting were Gerald S. Craig, Wm. C. Van Deventer, Ellsworth S. Obourn, Ira C. Davis, Ira Dubins, John N. Moore, William Reiner, Herbert A. Smith, Harley F. Glidden, Vaden W. Miles, Thomas P. Fraser, Clarence H. Boeck, George G. Mallinson, Abraham Raskin, Jerome Metzner, Edward K. Weaver, Waldo W. E. Blanchet, Clark Hubler, Nathan S. Washton, Mervin E. Oakes, Clarence M. Pruitt, and Margaret J. McKibben.

FINANCIAL REPORT OF NARST
APRIL 23, 1956

RECEIPTS	
Balance on hand	$ 520.00
Membership fees	480.00
Total	$1000.00
EXPENDITURES	
Western Michigan College of Education (printing, postage, etc.)	$ 74.75
NARST Expenses—Atlanta Meeting	55.17
Coffee Hour—Sherman Hotel	29.58
Printing programs	57.25
Ruth Moore—Dinner speaker	25.00
Secretary expenses	23.25
Science Education	735.00
Total	$1000.00
Balance on hand	00.00

Respectfully submitted

CLARENCE M. PRUITT
Treasurer, NARST

BOOK REVIEWS

FORNWALT, RUSSELL J. *School Information Sources for Educational and Vocational Counselors.* New York (33 Union Square West): Big Brother Movement, 1955. 6 P. $0.15.

This is an annotated bibliography of school information sources that should be very useful to educational and vocational counselors.

SMITH, VICTOR C. AND JONES, W. E. *General Science.* Philadelphia: J. B. Lippincott Company, 1955. 504 P.

This seems to be an outstanding general science text. It is most attractive in appearance replete with fine photographs and illustrations, many in color. The literary style is most readable and seems to be so psychologically organized as to appeal to students. The subject matter seems to be well-selected, being based upon the results of research studies and syllabi which indicate what subject matter is most generally considered of value by teachers and experts in the field.

The book is divided into nine units with suitable lesson-problems. Many demonstrations are interspersed with the textual material. Pupil helps include work lists for study, things to think about, pupil self-tests, lists of principles, list of related ideas, some things to explain, and good books to read. Each unit has an introductory overview.

Dr. Smith is head of the department of general science, Ramsey Junior High School, Minneapolis, Minnesota. Mr. Jones is chairman of the science department of the Evanston Township High School, Evanston, Illinois.

JOHNS, EUNICE (Editor). *Social Studies in the Senior High School.* Washington, D. C. (1201 Sixteenth Street, N. W.): National Council for the Social Studies, 1955. 108 P. $2.00.

This volume marks the completion of a noteworthy series of publications by the National Council for the Social Studies. The series, in addition to the above, have been:

- Mary Willcockson, Editor. *Social Education of Young Children: Kindergarten-Primary Grades.*
- Loretta Klee, Editor. *Social Studies for Older Children: Programs for Grades Four, Five, and Six.*
- Julian Aldrich, Editor. *Social Studies for Young Adolescents: Programs for Grades Seven, Eight, and Nine.*
- William G. Tyrell, Editor. *Social Studies in the College: Program for the First Two Years.*

This Senior High School volume includes programs for grades ten, eleven, and twelve. A number of persons have contributed to this volume. Part One discusses the social studies in secondary schools today, Part Two considers some factors to be considered in determining the curriculum for the Senior High School. Part Three presents selected programs in social studies in certain schools. Part Four explains how social studies programs may be improved. Part Five makes suggestions for further reading.

This volume should be of great service to secondary social study teachers across the land. Science teachers will find many practical suggestions applicable to the science field.

FINK, RICHARD. *American Democracy in Mid-Century.* Danville, Illinois: The Interstate Printers and Publishers, 1955. 85 P. $0.60.

This is a bibliography of recent books in the American Tradition. The bibliography is divided into three major and appropriate sub-headings: The American Character and Tradition, The Work and Wealth of America, and Problems of American Society and Culture. A brief statement describes each listed publication.

The pamphlet was prepared for The Progressive Education Association. There is an introductory statement by Professor George Axtelle of the School of Education of New York University.

Math Problems from Industry. Detroit Michigan: Educational Services, Department of Public Relations, Chrysler Corporation, P. O. Box 1919.

This free booklet presents some of the problems used in the Chrysler skilled—apprenticeship training program. Fifty-one problems are included. A knowledge of mathematics is an absolute essential to pass this course. This is an excellent booklet for all teachers of mathematics as well as their all too-often "mathematics shy" principals and superintendents!

CLARK, JOHN R. (Editor). *Emerging Practices in Mathematics Education.* Washington, D. C. (1201 Sixteenth Street, N. W.): The National Council of Teachers of Mathematics, 1954. 434 P. $4.50.

This is the Twenty-Second Yearbook of the National Council of Teachers of Mathematics. The content of the yearbook is organized about the following categories of emerging practices: Part One, Various Provisions for Differentiated Mathematical Curriculum; Part Two, Laboratory Techniques in Mathematics; Part Three, Teacher Education; Part Four, New Emphasis in Subject Matter; and Part Five, The Evaluation of Mathematical Learning.

Many teachers of mathematics, out of their teaching experiences and thinking, made contributions to the above five categories. Altogether this is a most significant professional yearbook—

useful to teachers of arithmetic, junior and secondary school mathematics, and even college teachers of mathematics. Supervisors of mathematics methods classes should find the book stimulating and professionally worthwhile. Science teachers can likewise find a wealth of ideas adaptive to the science teaching field.

REEVE, WILLIAM DAVID. *Mathematics for the Secondary School.* New York: Henry Holt and Company, 1954. 547 P.

Every teacher of secondary mathematics and every prospective secondary mathematics teacher should have and read this book and put into classroom operation the many fine suggestions made throughout the book. Surely we are in need of much better teaching of mathematics in high school. It is unfortunate that so few secondary mathematics teachers will ever hear of the book and the fewer still who will ever read even a part of it, and the very minimum few who will put many of the suggestions into actual classroom use. Too many secondary teachers already know all that is necessary to get by—why do a better job than the poor job that most of them are now doing. If they did do a better job, few people would appreciate it and most administrators would not recognize the improvement. So an unusually fine book falls largely on barren soil, almost to the point of futility in making for better teaching of secondary mathematics.

Surely this is one of the best books ever printed on the teaching of mathematics and could be so helpful to so many teachers. Science teachers will find many helpful suggestions here too.

Contents are: The Place of Mathematics in Secondary Education, Planning the Curriculum in Secondary Mathematics, Modern Curriculum Problems in Secondary Mathematics, The Training of Teachers in Secondary Mathematics, How to Plan and Teach a Lesson in Mathematics, The Teaching of Informal Geometry in Junior High School, The Teaching of Algebra, The Teaching of Indirect Measurement, The Teaching of Demonstrative Geometry, Mathematics for the Citizens, The History and Teaching of General Mathematics, The Mathematics Classroom and Its Equipment, and the Future of Mathematics Education in the Secondary School.

The author, Dr. Reeve, was for many years professor of the teaching of mathematics at Teachers College, Columbia University and also for many years served as Editor of the professional mathematics journal *The Mathematics Teacher.*

Continued from Front Inside Cover